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CHARACTERISTICS OF MATHEMATICS TEACHERS THAT AFFECT STUDENTS' LEARNING.
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TEACHER EFFECTIVENESS AS RELATED TO TEACHER-PUPIL INTERACTION, TO CLASSROOM CLIMATE, AND TO CREATIVE ABILITIES OF THE TEACHER WAS STUDIED. THE SAMPLE CONSISTED OF THE ORIGINAL 127 MATHEMATICS TEACHERS, GRADES 6-12, WHO PARTICIPATED IN THE SCHOOL MATHEMATICS STUDY GROUP (SMSG) EXPERIMENTAL INSTRUCTIONAL MATERIALS EVALUATION PROGRAM (1959-60). DATA WERE COLLECTED DURING THE 1960-61 AND 1961-62 SCHOOL TERMS. COMPLETE PREDICTOR AND CRITERION DATA WERE OBTAINED FOR 63 SUBJECTS AT THE END OF THE SECOND YEAR. THE SMSG MATERIALS WERE TAUGHT BY THE SUBJECTS IN ONE OF THEIR CLASSROOMS. THE STUDENTS WERE PRE- AND POST-TESTED FOR MEASURES OF (1) EDUCATIONAL AND MATHEMATICAL PROGRESS, (2) ATTITUDE, AND (3) APTITUDE. CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS WERE DISCUSSED UNDER THESE HEADINGS--(1) TEACHING EXPERIENCE, COURSES AND GRADES, AND PROFESSIONAL PARTICIPATION, (2) TEACHER PREPARATION TIME, (3) REPORTS OF TEACHER AND PUPIL ACTIVITIES, AND (4) STUDENT ATTITUDES. THE RESULTS SUGGESTED THAT THE CONVENTIONAL QUALIFICATIONS OF TEACHERS DID NOT DIFFERENTIATE TEACHER EFFECTIVENESS AND THAT TEACHER EFFECTIVENESS POSITIVELY AFFECTED STUDENT ATTITUDES TOWARDS TEACHERS, METHODS, AND THE OVERALL SCHOOL CLIMATE. (RS)

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CHARACTERISTICS OF MATHEMATICS TEACHERS THAT AFFECT STUDENTS' LEARNING

Cooperative Research Project No. 1020
Contract No. SAE-8993

Principal Investigator: Paul C. Rosenbloom

Subproject Directors: E. Paul Torrance and Ned A. Flanders

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September 1966

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Minneapolis, Minnesota

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The senior author has since 1962 carried with him a deep burden of regret concerning the delay in completing the report. These have indeed been stressful years for him and it is his hope that this report will still be useful in advancing knowledge concerning teacher effectiveness.

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September 1966

Chapter 1

TEACHER CHARACTERISTICS AND THE INTRODUCTION OF NEW CURRICULAR MATERIALS

A general problem throughout education has been the determination of what teacher characteristics affect the learning of students. In spite of its tremendous and pervasive importance, however, there has been little educational research bearing directly upon the problem and generally this has not been very penetrating, especially in the conceptualization, identification, and measurement of teacher characteristics. The problem of determining what teacher characteristics affect student learning becomes especially crucial in the selection and training of teachers to introduce new curricular materials such as those developed by the School Mathematics Study Group. Even if this information were not used in the selection of teachers to introduce these materials, information about the characteristics of teachers that facilitate the learning of such materials would be useful to those who conduct workshops and other educational experiences for such teachers and to the teachers themselves.

One of the problems of the directors of the School Mathematics Study Group (SMSG), and the Minnesota National Laboratory in particular, was to determine whether the new curricular materials produced by SMSG are adapted to the wide variation in teacher ability. Through the student materials and teacher manuals, efforts have been made "to build in" effective ways of learning for students and effective patterns of teacher behavior. It is important to know the extent to which students and teachers respond constructively to these efforts and whether or not this kind of constructive response is related to student learning. It was considered important by the Director of the Minnesota National Laboratory to know whether any special qualifications are required for a teacher to use the materials adequately and what aids should and can be given the teacher to enable him to teach the materials effectively. It is obvious, of course, that such information would provide useful clues concerning solutions of the larger general problem of selecting, appraising, and educating teachers.

Barr and his associates (1946) tried to predict pupil gain in achievement from data available while the teacher was an undergraduate. None of the factors they considered had a very high correlation with student learning as measured by achievement gains. In an earlier study in social studies, Barr (1929) had pioneered in conceptualizing and observing a variety of teacher characteristics, but he had used the ratings of experts instead of pupil gains in achievement. He combined eleven items that showed some promise into scales called the Index of Meaningful Discussion and the Index of Immediate Recall. The Index of Meaningful Discussion contained the following items, some of which are of specific concern in the present investigation:

1. Percent of fact questions on unprepared material
2. Percent of thought questions on unprepared material
3. Percent of thought questions dealing with local situations
4. Number of participations growing out of spontaneous pupil discussion
5. Number of teacher explanations
6. Number of times teacher presented factual information
7. Times teacher raised a question as to the correctness of a pupil response.

The Index of Immediate Recall contained the following items:

1. Questions demanding recall of specified fact
2. Number of factual questions on prepared material
3. Number of thought questions on prepared material
4. Number of times teacher indicated answer correct.

Barr's study has been criticized for its inefficient methods of recording behavior. A part of the present study represents an attempt to obtain data similar to much of those obtained by Barr in a more economical and efficient manner, through teacher logs and self reports, and to employ as criteria measures of student learning in mathematics.

In intensive and elaborate studies of teacher characteristics, Ryans (1947, 1960) included measures of classroom behavioral patterns. He did not attempt to correlate his measures with student learning as measured by achievement gains. Wright (1959) and McKeachie (1959) have developed rationales for the observation of mathematics teaching, but apparently they have made no attempts to validate their observations by measures of student achievement.

The major gaps in knowledge that concerned the investigators in the present study center around the use of measures of the thinking characteristics of teachers (as reflected in teacher logs and self reports) and measures of classroom interaction (as measured by observations and a pupil questionnaire) as predictors and measures of gains in achievement and student aptitude in appropriate regression equations as criteria of teacher effectiveness.

Previous Research in the Minnesota National Laboratory

In 1958, the Minnesota National Laboratory for the Improvement of Secondary Mathematics was established to provide facilities for statewide testing of the mathematics materials being bproduced by the National School Mathematics Study Group (SMSG, Newsletter No. 2, 1959). With Professor Paul C. Rosenbloom, the Principal Investigator in the present study, as director, this Laboratory became a part of the Division of Instruction in the Minnesota State Department of Education. During its first year, the Laboratory conducted two experiments, one in the seventh and eighth grade and one in the ninth grade. Twenty-one teachers participated in the first and fifteen in the latter. In 1959-60, the experiment included a total of 127 teachers from grades six through twelve.

Below the ninth grade, the School and College Ability Tests (SCAT) were given as a measure of aptitude and in the ninth grade and above the Differential Aptitude Tests (DAT) were given. The Sequential Tests of Educational Progress (STEP) in Mathematics were given as pre- and post-tests in September and May respectively. The measure of effectiveness used in identifying the most and least effective teachers in these early studies, as well as in the present one, is the regression coefficient of the post-test achievement scores of their pupils on the pre-test achievement and aptitude scores. While it is true that the STEP tests do not assess some of the new and specific objectives of the SMSG materials, they are generally accepted as assessing a variety of commonly accepted objectives of secondary school mathematics education. Furthermore, leaders in the production of the SMSG materials were anxious to be able to answer the inevitable questions as to what losses and gains in the achievement of present goals could be expected from a change to the SMSG materials (SMSG, Newsletter, No. 10, 1961).

Intrigued by some of the teacher characteristics and classroom behaviors revealed by the teacher logs submitted in the 1958-59 study, Rosenbloom asked Flanders to seek to differentiate the five most and five least effective teachers according to his criteria on the basis of the classroom interaction revealed by the logs. Similarly, he asked Torrance to try to differentiate them on the basis of their thinking characteristics. The teachers had been instructed to select any two days the first week and submit a log of teacher and pupil activities. For the next week, they were asked to select any two of the other three days of the week. They continued in this way for the remainder of the school term. They were asked to report such teacher activities as the following:

Advance preparation
Introduction of present phase of work
Demonstrations
Questions raised by teacher
Explanations to class and to individual students
Independent time
Homework assigned
Materials studied by teacher
Suggestions
Evaluation of effectiveness of material, teaching, and learning.

They were also asked to include the following aspects of student activity:

Group activities
Individual activities
Evidence of interest in non-assigned work
Class discussions
Incidents of discovery or non-discovery
Extra problem solving
Math club, fair exhibits, choice of courses for next year.

The logs were of a free-response type, some giving an excellent picture of the thinking of the teacher and his pupils and others revealing little concerning these processes.

Torrance first analyzed the daily logs of the five most and five least effective teachers in the 1958-59 experiment in an attempt to classify the types of mental operations represented by the teacher and pupil activities reported. Guilford's mental operations (cognition, memory, convergent production, divergent production, and evaluation) were adopted for this purpose (Guilford, 1959). The analyses indicated that the distribtuion of activities among the mental operations categories for the two groups differed significantly. The more effective teachers tended to report more thinking activities (convergent, divergent, and evaluative) than the less effective ones who reported proportionately more recognitive and memory activities.

A new scheme was then devised for analyzing the evaluative behavior of these teachers as reflected in their logs. The categories used were: negative evaluation, positive evaluation, and trouble-shooting, diagnostic, or hypothesis-making and testing evaluation. The more effective teachers were found to report far more of the trouble-shooting or hypothesis-making and testing activity, whereas the less effective ones reported a greater proportion of negative and positive evaluation.

The latter part of this investigation was replicated on the basis of the logs submitted by teachers participating in the 1959-60 experiment (Torrance, 1965). The logs of the 14 most and 14 least effective teachers according to the criteria developed by Rosenbloom were analyzed according to essentially the same procedures as had been used in the earlier study. The results obtained were almost identical to those obtained earlier. Detailed examination of the hypothesis-making behavior of the two new groups indicated that the thinking reflected by the hypothesis-making behavior of the less effective teachers tended to be quite vague and general and not very insight-producing. They also tended to report conclusions or hypotheses as having been tested and in a finalistic, absolute manner. The results also suggested that teachers whose evaluations are predominantly positive may actually be unaware of the difficulties their pupils are having in learning.

A major limitation of the data produced by the 1958-59 and 1959-60 teacher logs was lack of uniformity in reporting and difficulties in quantification. As will be described in Chapter 3, the direction taken in the 1960-61 study was to construct a checklist covering most of the kinds of behavior obtained in the earlier logs and combine with it a series of nine end-of-the-month reports which in actuality were intended as productive thinking tasks to reveal further the thinking characteristics of the teacher. The direction taken in the 1961-62 study was to repeat each month three of the more promising end-of-the-month reports designed as productive thinking tasks. Measures of pupil attitudes were also added at this time.

Special Concerns of This Study

In relation to the SMSG concern as to whether their new curricular materials are adapted to the wide variations in teacher ability and qualifications, the first concern was with the most commonly used measures of teacher qualification and ability. Is there any correlation between the teacher's effectiveness as determined by student learning and grossly measurable qualifications such as experience, grades in undergraduate and graduate mathematics courses, and activities in the teaching profession such as conducting mathematics clubs, working on curriculum committees, professional writing, and the like? The analysis of the data from 25 classes in grades six through eight in the 1958-59 study had yielded no significant correlations. It was believed, however, that the sample was not large enough, in the light of the variability of teacher effectiveness, for the results to be conclusive.

In view of the negative results obtained in the 1958-59 study it was decided to consider the kinds of variables that had been suggested by Flanders and Torrance. Thus, the study reported herein asked such questions as the following:

> Is teacher effectiveness related to the pattern of interaction between teacher and student and to the classroom climate created by this interaction? The hypothesis is that the measures of classroom interaction will be related significantly to pupil gains in achievement, corrected for aptitude.

Is teacher effectiveness related to the thinking abilities of teachers as reflected in the logs submitted by teachers throughout the school term? It was hoped by the investigators that they could devise teacher rating forms that would yield measures of productive thinking ability and that these measures might be related significantly to pupil gains in achievement, corrected for aptitude.

Chapter 2

THE LITERATURE ON MATHEMATICS TEACHER CHARACTERISTICS

Although there is practically no literature on the thinking characteristics of mathematics teachers, a variety of previous studies provided guides for developing the instruments used in this study, in analyzing the data, and in interpreting the results. The most useful clues have come from reviews of the literature on the teaching of mathematics, studies of teacher characteristics and qualifications, attitudes toward mathematics, the role of assessment and evaluation on mathematics teaching, studies of teacher behaviors and classroom styles, some of the literature on teaching and learning methodologies, studies of student thinking processes and skills, and studies of the nature of mathematics learning and problem solving. Some of the more relevant studies in these areas will be reviewed in this chapter.

Reviews of Literature on Mathematics Teaching

Some of the more recent reviews of the literature on the teaching of mathematics help to give perspective to the body of literature with which this chapter is concerned. Dodes (1953) reviewed the literature of mathematics teaching and organized it under seven headings representing content, methodology, and the role and function of the teacher. Johnson (1957) reviewed and discussed the implications of research in the psychology of learning for the teaching of science and mathematics. Henderson (1963) in an analysis of research on the teaching of secondary school mathematics discussed findings under three headings:

(a) Methods research -- which aims to determine which factors are maximized and minimized by a certain teaching method. The two major methods of teaching secondary school mathematics are the "tell and do" and the heuristic or discovery method.

(b) Curricular research -- which focuses on the relationship between the subject matter taught and student behavior.

(c) Research which studies the relationship between teacher or teaching variables and those student behaviors which under various hypotheses are related to these variables.

More recently, Brown and Abell (1965) reported on the results of a questionnaire survey of research in progress at U.S. colleges and universities on mathematics teaching during the 1961-62 calendar year.

Studies of Teacher Characteristics and Qualifications

Calabria (1960) studied the educational and professional background of a group of secondary school teachers nominated as "effective" in a statewide survey of New York school administrators.

Of a total of over 1300 teachers nominated, 770 responded and 250 were selected for a check-list project; the balance were sent postcard inquiries. Information was secured in the following four areas: (1) undergraduate preparation in major field and professional education; (2) teaching experience; (3) certification status; and (4) graduate training. Tabulations indicated that successful secondary school teachers in New York were characterized by:

(a) A greater emphasis on major field rather than on professional educational preparation as undergraduates.

(b) Considerable post-graduate training: 86 percent of the group had an M.A. degree or equivalent; 67 percent held graduate credits beyond the M.A.

(c) 70 percent had more than 10 years of actual teaching experience; over 80 percent of the group had had preparatory practice teaching experience.

Leonhardt (1962) in a doctoral study examined the relationship between achievement in mathematics and selected educational factors. Forty-five secondary schools in Nebraska were randomly selected, 15 from each of three different-sized enrollment groups. Coop Math tests were administered to approximately 1300 students in the 45 schools and further study made of the two highest and two lowest ranking schools in each enrollment group. Achievement was found to be positively related to the size of school and to school attendance in a town rather than a rural elementary school.

Examination of teacher experience and training revealed that teachers in the high ranking schools had more undergraduate and graduate preparation in mathematics and held longer tenure in their positions.

In another doctoral study, McCardle (1959) compared the mathematics achievement of pupils of teachers grouped according to Minnesota Teacher Attitude Inventory (MTAI) scores (high, medium, low). Included in the study were 13 Minnesota schools, with a total of 29 teachers and 1643 students enrolled in first-year algebra courses. Measures obtained included pre- and post-test scores on the Iowa test of ability to do quantitative thinking, the Davis functional competence in mathematics test and the Elementary Algebra Test, Form 2.

Differences in achievement of pupils within the three teacher groups were noted. Significant differences in mean gains on the Iowa and Davis tests were found, with pupils of teachers in the high MTAI group scoring higher than those in the other two groups. No significant differences in scores on the algebra achievement test were noted. McCardle hypothesized that high-scoring teachers on the MTAI are not as "textbook bound" as teachers falling in the middle and low scoring group -- and that they instruct in a way that results in significantly greater achievement on tests of quantitative thinking and functional mathematical competence.

Analysis of teacher qualifications indicated that all of the teacher sample had completed the B.A. degree and 14 of the 29 had taken some graduate work. Twenty-six of the 29 reported either an undergraduate major or minor in mathematics. Years of teaching experience ranged from five to 27 years, with a median of 19 years teaching experience.

Schunert (1950) in another doctoral study of teacher characteristics and pupil mathematical achievement reported a number of factors significantly associated with achievement in Elementary Algebra and Plane Geometry. He reported that:

(1) Classes taught by teachers who had more than eight years of experience exceeded the achievement of classes taught by teachers with less experience.

(2) Classes of teachers who were graduates of state universities or private colleges exceeded those of teachers who were graduates of teachers' colleges. The amount of college mathematics studied by the teacher was not significantly related.

(3) Teaching factors such as the use of differentiated assignments, the use of life applications and frequent review were reported as significantly related to achievement level.

Attitudes toward Mathematics

Attitudes as a variable in mathematical achievement have come under scrutiny in several recent studies. Ellingson (1962) in a study of junior and senior high school mathematics classes in Oregon compared pupil measured attitudes, pupil attitudes toward mathematics as estimated by teacher rating, classroom grades and scores on an achievement test. The Mathematics Attitude Inventory devised by the author was a 50-item Thurstone type scale concerned with four dimensions: (1) goals of mathematics instruction; (2) mathematics for everyday living; (3) understanding our modern culture and (4) over-all attitude toward mathematics. Results indicated a significant positive relationship between attitudes toward mathematics and achievement. In addition, Ellingson reported a correlation of .48 between mathematics attitudes as measured by the Inventory and teacher estimate of pupil affective responses.

In a similar study, Garner (1963) reported on his work with 45 first-year algebra teachers and a student enrollment of over 1100 pupils. Each pupil and teacher was administered an attitude inventory especially designed for the study; this was done at the beginning and close of the school year. Academic preparation in college mathematics and in professional educational courses was assessed for each teacher. Significant differences were found between teachers' background in mathematics and pupil achievement in algebra. A similar positive relationship was reported between teachers' attitudes toward algebra and the end-of-course attitudes of their pupils. A similar trend has been reported by Alpert (in Feierabend, 1959) who noted that during the school year attitudes of elementary school students tend to shift toward the attitudes of their teacher.

The effect of attitudes on performance in mathematics was investigated by Aiken and Dreger (1961) within a group of 127 entering college freshmen. In addition to scores on a Likert-type mathematics attitude scale, three classes of variables were considered:

(1) Achievement measures, including Differential Aptitude Test (DAT) scores, classroom mathematics grades and Coop Math Pretest for college students score

(2) Personality measures, including the Minnesota Counseling Inventory and a personal data sheet

(3) Earlier experiences with mathematics ratings of former math teachers, parental attitudes toward math and parental encouragement; traumatic experiences with math, etc.

The Investigators concluded that attitudes toward mathematics are related to intellectual factors and achievement, with an emphasis on the role of direct experiences rather than temperament contributing to such attitudes.

The idea that attitudes toward mathematics are a culminative phenomenon, with one experience building upon another is suggested also by Norton and Poffenberger (1959). Two groups of entering freshmen were identified and studied at the University of California, in an attempt to investigate the development of attitudes toward mathematics -- a "positive" group that had indicated a strong liking for mathematics and a "negative" group that had indicated strong dislike.

No differences in over-all high school grades, ability or attitudes toward school in general, nor in reported emotional adjustment in various life areas were indicated. Factors significantly differentiating the two groups were the attitudes of the fathers toward mathematics and the expectations of both fathers and mothers of mathematical achievement on the part of their children. While achievement expectations on the part of parents were the same for the two groups in regard to school subjects in general, there was a significant difference between the two in expectations regarding achievement in mathematics.

The two groups also differed in their attitude toward their beginning algebra course, with the "negative" group significantly more critical of their teacher than the "positive" one. Further analysis revealed an interesting difference in regard to relationships between algebra teachers and the subject. The "negative" group disliked the subject in spite of liking the teacher, whereas for the "positive" group there seemed to be a closer relationship between liking the teacher and the subject.

One of the most extensive investigations of the role of psychological variables in mathematics education has been reported by Alpert (1963). The study of seventh grade mathematics students, their teachers and parents was part of an evaluation study of SMSG materials begun in 1959. The major study was carried out during the 1960-61 academic year and included 270 middle class suburban seventh graders; half of the sample was enrolled in SMSG classes, the other half in traditional mathematics classes. A number of student, teacher and parent variables were considered, with the following conclusions:

(1) Significant and positive correlations were found between student performance (Metropolitan scores, 6th and 7th grade mathematics grades) and

    (a) high mathematics attitudes
    (b) high mathematics facilitating anxiety
    (c) low mathematics debilitating anxiety
    (the anxiety measures were based on two scales designed to measure anxiety specific to mathematics examinations)

    (d) high self concept
        (especially school self concept and a particularly strong relationship for boys; i.e. more of a boy's life is bound up with his performance in school)
    (e) high I.Q.
    (f) high level of aspiration

(2) In addition to being related to performance, the variables enumerated above indicated a strong degree of intercorrelation. The authors point out the self-perpetuating cycle of level of expectation influencing performance which influences level of expectation, etc.

(3) The relationship between congruent attitudes of parents and students was again pointed out. Interesting sex differences emerged: for boys alone, favorable attitudes toward math were positively correlated with parental importance placed on grades as well as with parental demands for high grades. For girls, favorable attitudes toward mathematics were negatively correlated with parental importance placed on grades. For both sexes, favorable attitudes were positively correlated with parental response to two "competition scales" -- competition viewed as necessary in the modern world and evaluated by the parents as "good."

(4) Four clusters of teacher-variables were outlined:

    (a) high theoretical mathematics interest (e.g., mathematics important as a logical system)
    (b) high psycho-social concern -- concern with the student as a psychological being, etc.
    (c) involvement in teaching
    (d) personality characteristics cluster -- e.g., warmth, patience, little social distance maintained between teacher and student, etc.

In general, anxiety and affect were the student variables that related to the above, with differentiating relationships, according to pupil sex. For boys, the four teacher clusters were associated with low debilitating anxiety; in regard to affect, boys responded with positive feelings toward the theoretically-oriented and involved teachers, regardless of the teachers sex. In general, it appears that the more "objective" factors (theoretical orientation and involvement in teaching) do not depend on the teacher's gender, while the more subjective or interpersonal factors (psycho-social concern and personality characteristics cluster) are effective only along the same sex lines.

(5) In considering differences between SMSG and the traditional curriculum, the over-all results indicated that the experimental program did not increase students' positive feelings toward mathematics, either absolutely or relative to the traditional program. There was, however, what the investigator termed powerful interaction between program and teacher, suggesting that the combination of a certain type of mathematics teacher with a certain mathematics program may generate results which are significantly stronger than the sum of uncombined parts. For example, in cases where a teacher teaches both SMSG and traditional classes, a highly theoretical orientation was found to lead to high positive affect in SMSG classes but not in non-SMSG classes.

(6) A look at attitude change after the course of a year's study was of interest. In the fall, at the start of the school year, the SMSG students were found to be more favorably oriented toward mathematics than non-SMSG students. Re-examination at the end of the year revealed that while non-SMSG student mathematics attitudes remained fairly constant, SMSG student attitudes fell.

The role of attitudes as a mediating influence in the sex differences in achievement in problem solving -- differences which have been well documented in a number of studies involving both high school and college students -- has been suggested by Taylor (1959). He points to Alpert's findings that during the school year attitudes of elementary school students tend to shift toward the attitudes of the teachers. Since most elementary teachers are women, most of whom have distinctly unfavorable attitudes toward mathematics and toward analytic thinking more generally, and since girls would seem to be more likely to identify with and hence be influenced by the attitudes of women teachers, the inference is made that these early experiences may lay the groundwork for the sex differences noted later in the school career.

The Role of Assessment and Evaluation of Mathematics Learning

Balch (1964) has offered a comprehensive review of the research literature of the past 30 years, in order to answer the question of how and to what extent the evaluating instrument (and practices) influence the nature and consequence of learning.

Studies conducted to date on the type of tests used, frequency of testing, time between studying and testing, knowledge of results and student-teacher influence exhibit few conclusive results or general agreement on principles. The two factors related to the evaluating instrument that seem to have most influence on learning are the student's awareness of the nature of the instrument while he is preparing for it and his knowledge of the results after he has taken it. Balch points out that whether these factors affect mainly his learning or his test-taking ability needs to be examined.

McKeachie (in Balch, 1964) points out that interactions among teacher characteristics, teaching methods, student characteristics and other variables appear to be significant determinants of instructional effectiveness and are likely to become increasingly a focus of research. Bills has pointed to the effect of agreement or disagreement between student and instructor values as determiner of marks.

In a more recent study, Page (1958) reports the effect of teacher evaluation (74 randomly selected secondary teachers, 2139 students) under three different treatment conditions. Following a routine examination, tests were returned to students with (1) a grade, but no comment; (2) a grade and a specified comment (structured according to grade level but generally encouraging) and (3) a grade plus free and unstructured comments by the teacher (evaluative in nature but generally encouraging).

Comparison with the results of the next examination indicated a measurable and significant effect of teacher comments, with none of the differences attributable to school or grade level or student ability. Students in the free comment group achieved higher scores than those in the specified comment; students in the latter achieved higher than those who did not receive teacher comments.

Another relevant study is that of Jecker (1964) who took a look at the relative value of nonverbal and verbal cues in teacher accuracy in making judgments of student comprehension. Subjects were teachers grouped according to experience: (67 student teachers, 59 inexperienced teachers and 46 experienced teachers). All were shown 20 short sound-film recordings of ten students receiving instruction and were asked to rate student comprehension. One third of the group saw the picture with sound; another third heard only the sound and the balance were shown the film, but without sound.

Jecker reported that when sound is absent all groups of teachers were inaccurate in judging student comprehension; when sound was present, whether or not the picture is seen, all of the groups exceeded chance but did not differ significantly from each other. He concludes that teacher ability to assess nonverbal feedback is not related to teaching experience and accuracy is generally low.

An interesting cross-cultural attempt to understand differential factors affecting mathematics learning was reported by Johnson (1962). A random stratified sample of 1619 ninth grade students in a five-county metropolitan area in Minnesota and 3134 students from a similar area near London was studied. Each subject was administered a British (National Foundation for Education Research) and American (STEP) achievement test, the Raven Progressive Matrices Test and a questionnaire to ascertain experiences and attitudes hypothesized to affect mathematics learning. In addition, each teacher was asked to respond to a questionnaire designed to identify distinctive classroom practices. Ninety-three British and 62 American teachers returned the questionnaire.

Differences in classroom evaluation techniques were of interest. Chi-square analysis indicated that the American teachers more frequently mentioned the use of daily drills, the use of some type of competition within the class, weekly or more frequent tests or examinations, the assignment of failing grades in the course, and the failing of students the preceding year.

In contrast, the British teachers reported a greater use of workbooks and other laboratory methods, and awards in class for superior performance in mathematics.

The author notes that the over-all comparisons of the two subsamples seem to show that between-country differences are not great, with the most noticeable ones the American emphasis on competition and failure, especially from day to day. The British stress the comprehensive or "leaving examinations" and the preparation for them. The British tendency to assign less homework and spend less time in mathematics class while still accomplishing approximately the same level of achievement seems, to the investigator, to warrant further study.

Teacher Behaviors, Classroom Styles

A number of studies have been reported during the past ten years which have focused on the relationship between teacher classroom behavior and specified student outcomes. A variety of observational techniques and measures of classroom interaction have been developed.

Amidon and Flanders (1961) reported confirmation of their hypothesis that dependent-prone children would be sensitive to experimentally-induced direct and indirect teacher influence in a geometry classroom setting. A total of 140 dependent-prone students were selected out of a eighth grade population of 560 and subjected to four experimental learning treatments: (1) direct teacher influence, clear goals; (2) direct teacher influence, unclear goals; (3) indirect teacher influence, clear goals; and (4) indirect teacher influence, unclear goals. Teaching sessions were followed by 15-minute periods of practice in problem solving; then post-tests of achievement were administered.

Results indicated no differences between clear and unclear goal treatment, but differences between the direct-indirect groups were significant, in favor of the indirect condition. Mean gains for the latter group were also significant when intelligence and pre-achievement scores were controlled. The authors compared their findings with an earlier study with the original total group (N = 560) and attribute the positive relationship cited here to the personality variable of dependent-proneness.

Herman (1965) also used the Flanders system of interaction analysis in his study of the relationship between teachers' verbal behavior and childrens' interest in social studies. The author analyzed the verbal patterns of 14 teachers and asked their fifth grade pupils (N = 425) to rank academic subjects in the order in which they liked them.

Observers visited classrooms and taped entire lessons of social studies on four selected days of a six-week long unit of work. Classes were grouped according to measured ability and results compared by ability level. Herman found that as the intelligence level of the group increased, and simultaneously as the verbal patterns of the groups of teachers became less direct, the number of children who liked social studies increased.

Cogan (1958) grouped teacher behaviors into three categories, on the basis of responses to a "Pupil Survey" regarding the frequency with which a specified teacher performs certain actions.

Independent variables of teachers' "inclusiveness" (causes pupils to feel their goals, sensibilities and interests are taken into account), "preclusiveness" (student perception that important classroom decisions are made without them) and "conjunctive behavior" (level of demand, ability to communicate, competence in classroom management) were examined and their relationship to amount of required and self-initiated work output observed.

Cogan concluded that average scores for teacher "inclusiveness" differentiated sharply between teachers and are positively and significantly related to average scores for required and self-initiated work. He considers "inclusiveness" then to be an observable and measurable trait of the teachers in his sample and the degree to which this trait is reported is related to the degree of productivity reported by pupils.

Dollins (1960) studied the effects of teacher praise for arithmetic performance on an adjustment measure (pre- and post-test scores on the California Test of Personality) and tests of arithmetical computation. Differences between the three experimental praise groups were not significant, with no gain in adjustment score or arithmetic effectiveness.

Guggenheim (1961) investigated the influence that dominative and integrative classroom climates (as measured by the Wrightstone Teacher-Pupil Rapport Scale) have on the learning of third grade mathematics. Differences in achievement were not significantly related to the effects of classroom climate.

Davies (1961) attempted to get a measure of the personality variables which underlie teacher classroom behavior. Comparison of measures obtained from the MTAI, Cattell's 16 Factor personality test and use of Flanders interaction system did not reveal any significant relationships.

Teaching and Learning Methodologies

In a particularly relevant study which compared differing teaching methods with regard to achievement as well as interest and attitude change, Kushta (1962) compared ninth grade algebra students in five schools. In each school the same teacher taught two classes (a control group taught by the topic method and an experimental group taught by the concept method). The two classes were comparable in predicted success in first-semester, ninth grade algebra.

A total of 262 students participated in the study, with the experimental period continuing for a period of fifteen to seventeen weeks. School records yielded data on the intelligence quotient, arithmetic level and reading level scores of all students at the beginning of the study and an attitude scale and interest measure were administered. At the end of the experiment, students were given a test to measure manipulative skills, the understanding of the nature of mathematics and a re-test on the interest and attitude measures. The following results were reported:

(1) There were no significant differences in degree of manipulative skills developed by students taught by either method.

(2) There were significant differences, in favor of the concept method in acquired understanding of the nature of mathematics as a whole.

(3) No significant differences in change toward more favorable attitudes in mathematics emerged. In the three centers with the greatest number of students participating in the study, the means favored the topic method classes.

(4) There was non-support of the hypothesis that students taught by the concept method will change in their interest to a significantly greater intensity and give mathematics a significantly greater importance in their anticipated future work. In the category of future interests, the means at all centers favored the topic method; in intensity of interest, the means at three centers favored the concept method.

McKeachie's study of 30 college instructors (in Feierabend, 1959) and their students in college algebra, elementary psychology and second-year French courses pointed out interesting differences. Students rated the mathematics teachers they liked best as those providing more structure than the poorer instructors. Observation records of highly rated teachers showed little inattention, a high degree of student participation and a good deal of informal encouragement. McKeachie observes that these are characteristics on which most mathematics classes are low as compared with other academic areas.

In French classes, student satisfaction with structure and standards correlated significantly with teacher effectiveness, as measured by student performance on both oral and written examinations.

In psychology, McKeachie reports that the results were more puzzling. Those instructors who were more effective as measured by their students' performance on an objective test tended to be the least effective as measured by their students' performance on an essay test. He suggested that in talking about teaching effectiveness, there is a need to ask the question "effective for what?"

Kersh (1962) posed the hypothesis that self-discovery modes of teaching motivate students to practice more, to remember more and transfer more than does a direct approach. Three groups of

30 students each were taught two novel rules of addition by a programmed booklet procedure. Subsequently, one group was given guidance in discovering explanations for the rules (guided discovery); another was taught the explanation by a programmed booklet (directed learning) and the remaining given no further instruction.

Tests of recall and transfer were given three days, two weeks and six weeks later, with results favoring the rate learning and guided discovery group. A questionnaire indicated that the guided discovery group practice more in the time interval between the learning and test period (i.e. did more non-required work) than students in the other group. Results were significant at the .05 level.

Scandura (1964) reported non-conclusive results in his comparison of exposition and discovery modes of teaching. He comments on the importance of timing and suggests the potentially strong effect of within-methods differences on behavior, as it relates to various education objectives -- specific skills, transfer and/or attitudes. Hanson (1962) also reported no significant differences in attitudes and achievement of three mathematics class treatments which varied class length as well as the use of extended discussions and other enrichment-types activities.

Studies Concerned with Student Thinking Processes and Skills

Although conducted in other subject matter areas, several studies have been reported which hold promise for assessing similar variables in mathematics classes.

Heath (1964) compared cognitive preferences of students completing an experimental (Physical Science Study Committee) and traditional high school physics course. Included in the study were 30 teachers and 1027 students in the experimental group and 49 teachers, 2110 students in the traditional course. The instrument used was the Cognitive Preference Test, a 20-item test offering respondents an opportunity to demonstrate a preference for: (1) fundamental principles; (2) questioning; (3) practical application and (4) memory for specific facts and terms. Results indicated that:

(a) PSSC students demonstrated a stronger preference for fundamental principles and questioning than did traditional course students; the latter preferred memory for facts and practical applications to a greater degree.

(b) Test preference for fundamental principles and questioning was more positively related to achievement scores for PSSC students than control. (Both groups were given the Coop Physics Achievement Test and the PSSC Achivement Test.)

(c) Preference for facts and terms and for practical applications was more negatively related to achievement test scores for PSSC students than controls.

(d) Differences between the two groups were significant on three of the four Cognitive Preference Test scales.

Creutz (1965) compared ninth and tenth grade students in a current events class, to assess the effect of emphasis on developing specific skills in critical thinking upon the improvement in these skills.

Pre-test scores on the Watson-Glaser Test of Critical Thinking revealed no significant differences between the control (N = 22 pupils) and the experimental (N = 30) group. Members of the experimental group were given special skill exercises and assignments designed to sharpen critical thinking skills. Post-test scores revealed a significant gain (.01 level) for the latter group.

Bloom (1953) used a method of stimulated recall in his investigation of the nature of students' conscious thoughts during classroom situations employing lecture as compared to discussion method of teaching. Subjects in the study were college students in five lecture classes (three in social sciences, one each in humanities and biological science) and 29 discussion classes drawn from social sciences, humanities, natural sciences and mathematics.

The method employed by Bloom consisted of interviewing students within 48 hours after a particular class session and playing back a tape recording of the entire session. Student recall was analyzed in a four-category system: thoughts about other persons, thoughts about the self; irrelevant thoughts, relevant thoughts.

He reports confirmation of his hypothesis that: (1) lectures are less successful in holding student thoughts actively to the immediate situation; (2) discussions evoke more thoughts classed as problem-solving in nature -- attempts to answer a problem or question, to synthesize and integrate ideas being considered, to reconcile conflicting points, etc.; (3) more active as compared to passive thinking is engendered by the lecture method.

Studies of the Nature of Mathematics Learning, Problem Solving

Concern with the nature of problem solving and experimentation to determine the best way to effect learning transfer has been evident during the past twenty years. Hendrix (1947) advocated the usefulness of teaching aimed at unverbalized awareness (insight) and compared learning transfer under three experimental methods: Method I. The generalization was stated, then illustrated, then applied to a new problem. Method II. The unverbalized awareness method (the learner reveals possession of the generalization by his transfer behavior) and Method III: Learners are asked to state the rule they have discovered.

Haslerud (1958) confirmed Hendrix's postulate that dependently derived principles are more transferable than those that are given in a study conducted with 76 college students. Subjects were given the task of translating into 20 different codes of a series of common, four-word sentences. Rules were given for half of the problems; the other half had to be derived from examples.

A test of initial learning indicated better performance on those problems where the rule was given; on a transfer test a week later, students were given 20 different sentences, one for each of the coding principles employed earlier. Higher scores for problems which had formerly been derived were reported as contrasted with problems for which rules had been given. Haslerud reported that a control group of 24 given the second test did significantly poorer than the experimental group, thus confirming the value of the transfer from earlier learning experience.

The effect of *Einstellung* (a special kind of mental set characterized by a tendency toward mechanization in problem solving) has been the focus of a number of investigators. Luchins (1942) reported that after administering his basic experiment to over 9000 subjects he had found that recovery from mechanization is in general not large for adult groups and negligible in most elementary groups. He suggests that the solution to *Einstellung* is student experiences in learning the importance of discovering, selecting, evaluating and discarding facts and hypotheses in solving problems. He points out that the nature of most arithmetic and mathematic experiences, with emphasis on drill and blind repetition of certain rules and formulas, fosters the *Einstellung* development. His experiments suggest that the factor in determining whether or not an *Einstellung* developed seemed to be the attitude with which the subject viewed the task.

Miller (1957) in his studies did report a significant relationship between intelligence and Einstellung but suggests that teaching methods (routine or drill versus more flexible methods) played an important role.

Pringle (1965) in his study of 11-year olds in two junior schools (one with a traditional English and the other a progressive educational approach) reported contradictory findings. He supported Luchins view that intelligence does not affect rigidity but found no over-all differences in rigidity in his study, despite the differing curriculum approaches.

Gayne's theory (1962, 1963) that a hierarchy of learning sets (subordinate knowledges) supports any given task has been the theoretical base of several studies involving mathematics learning. In his earlier study, 118 seventh graders were given a learning program on solving linear algebraic equations. Also measured were basic abilities considered relevant, the rate of learning, performance in equation solving and transfer, and finally, achievement of the 22 learning sets in the hierarchy. The investigators reported confirmation of the hypothesis that the rate of mastering learning sets at progressively higher levels of the hierarchy is dependent upon mastery of subordinate learning sets.

In a later study, seventh graders were given a learning program on addition of integers -- and again the investigators reported that the acquisition of learning sets at successively higher stages of the hierarchy was dependent upon prior mastery of subordinate learning sets. Instances in accord with the theory ranged from 97 to 100 percent.

Other Evaluation Studies of New Mathematics Curriculum

The few reported comparative studies of experimental texts such as SMSG and traditional materials have produced conflicting results.

Shuff (1962) and Williams (1962) in companion doctoral studies of junior and senior high school algebra classes in Roseville, Minnesota, reported contradictory findings. Shuff compared relative effectiveness of SMSG and traditional texts at 7th and 8th grade levels and showed the traditional texts to be more effective. Williams used the same criteria (gain on STEP) and found, at the 9th and 10th grade level, no significant differences in achievement.

Osburn and Melton (1963), as part of a cooperative evaluation of new materials developed by Southern Illinois University, hypothesized that a different pattern of abilities might be called for in experimental as compared to traditional texts. A battery of aptitude tests and proficiency measures were used, in a search for predictors of achievement in three experimental and three traditional classes of beginning algebra. Analysis of results indicated that the aptitude tests used were equally valid in predicting proficiency in either course. He did find that spatial and mechanical reasoning tests were more valid for experimental class success; in addition, one part of the Orleans Algebra Prognosis Test and the Primary Mental Abilities Word-Fluency test gave similar results, while the Differential Aptitude Spelling Test gave characteristically higher validities in the traditional classes.

Chapter 3

STUDY PROCEDURES

The study described in this report was continued over a two-year period with basically the same design and subjects with some changes in the predictor instruments but not in the measures that were combined into the criterion measures. Where changes were made in the instruments, an attempt will be made to make clear the nature of the changes and the reasons for them.

Selection of the Subjects and Their Characteristics

From Chapter 1, it will be recalled that 127 teachers from grade seven through twelve had been selected for participation in the 1959-60 study. Since approximately one hundred of these teachers became the subjects of the present study, it is important to review the procedure by which they were selected (Rosenbloom, 1961). Application forms for participation by teacher and by school were sent to every superintendent and to heads of private schools in Minnesota. Since participation by both teacher and school was entirely voluntary and by application, the teacher and school populations were undoubtedly biased at least with respect to their attitudes toward educational experimentation.

A crude measure of teacher qualifications was set up in terms of experience, grades in undergraduate and graduate courses in mathematics, activities in professional organizations, and contributions to the advancement of mathematics teaching. The population of teachers was stratified according to this measure of qualifications, and schools were stratified by population of community. A random selection was made from each stratum. Thus, the subjects of the study included both well and poorly qualified teachers, and schools from large cities, small towns, and rural areas.

In 1959-60 mathematicians from the colleges and junior colleges in the state held two regional meetings per month -- one for teachers in grades seven through nine, and one for teachers in grades ten through twelve. The college teachers were instructed to answer specific questions and to provide a forum for discussion, but not to give lectures or otherwise to provide an in-service training program as at SMSG centers in other parts of the country. Some of the teachers participating in the study had had in-service education at summer institutes or at summer workshops in 1959. None of these activities, however, were in progress in 1960-61 and 1961-62, the period of the study described in this report.

By the time data collection got underway in the fall of 1960, attrition resulting from transfers, changes in assignment, resignations, and the like, reduced the number of participating teachers to 107 and reasonably complete predictor data were obtained for 81 of them. By the end of the year, complete criterion data were available for only 75 teachers. Nine of these were seventh grade teachers; 12, eighth grade; 11, ninth grade; 19, tenth grade; 13, eleventh grade; and 11, twelfth grade. They continued to be fairly well distributed among all strata insofar as qualifications and size of community were concerned.

In weighting experience in constructing the index of qualifications, five points were given for each year of mathematics teaching experience. On this basis, the distribution shown in Table 3.1 was obtained. From these data it will be seen that the median falls within the 41 to 50 (eight to ten years of experience) interval. The range is from five (one year) to 140 (28 years).

Table 3.1

Distribution According to Mathematics Teaching Experiences of Teachers Participating in the 1960-61 Minnesota SMSG Experiment

Interval	Frequency	Cumulative Frequency
0 - 10	6	6
11 - 20	6	12
21 - 30	6	18
31 - 40	14	32
41 - 50	16	48
51 - 60	6	54
61 - 70	2	56
71 - 80	21	77
81 or above	3	80
Not ascertained	1	81

In determining an index for undergraduate mathematics courses and grades, a grade of "A" was assigned a weight of 4; "B", 3; "C", 2; and "D", 1. The index for graduate courses and grades was obtained in the same manner and multiplied by 1.5. The distributions of indexes thus obtained are presented in Table 3.2. From this table, it will be seen that only a few of the subjects had extremely low indexes on the undergraduate course and grade criterion but that a relatively large number of them had low scores on the index determined by graduate courses and grades. In both indexes, there are wide ranges.

Table 3.2

Distribution of Undergraduate and Graduate Courses and Grades of Teachers Participating in the 1960-61 Minnesota SMSG Experiment

	Undergraduate		Graduate	
Interval	Frequency	Cum. Frequency	Frequency	Cum. Frequency
0 - 10	1	1	18	18
11 - 20	0	1	9	27
21 - 30	0	1	5	32
31 - 40	0	1	9	41
41 - 50	3	4	9	50
51 - 60	6	10	8	58
61 - 70	8	18	3	61
71 - 80	14	32	2	63
81 - 90	6	38	5	68
91 - 100	9	47	1	69
101 - 110	6	53	0	69
111 - 120	12	65	1	70
121 - 130	7	72	3	73
131 - 140	1	73	2	75
141 - 150	3	76	1	76
151 and above	4	80	4	80
Not ascertained	1	81	1	81

In determining the index based on participation, 20 points were given for each professional mathematics organization in which the subject participates. The distribution of indexes derived thereby is shown in Table 3.3. It will be seen that there is a great deal of variation in the extent to which the subjects participated in professional organizations. Eleven of them participated in no professional mathematics organizations and three of them participated in seven such organizations.

Table 3.3

Distribution of Scores on Professional Organization Index of Teachers Participating in the 1960-61 Minnesota SMSG Experiment

Interval	Frequency	Cumulative Frequency
0 - 19	11	11
20 - 39	18	29
40 - 59	24	53
60 - 79	10	63
80 - 99	9	72
100 - 119	2	74
120 and above	6	80

School Mathematics Study Group Materials

The history of the School Mathematics Study Group and its materials has been described in a variety of sources, one of the more available being an article by Moise in the proceedings of a 1961 National Conference on Curriculum Experimentation (Rosenbloom, 1964). The work of the School Mathematics Study Group (SMSG) got underway in earnest in the summer of 1958 under a grant from the National Science Foundation. Its director has been E. G. Begle, then at Yale University and now at Stanford University. The initial writing team consisted of about 40 people, about half from the schools and the other half from the universities. A similar arrangement involving collaboration between mathematicians and classroom teachers has been continued in all of the work of SMSG, according to Moise (1964, p. 77).

In the summer of 1959, the writing teams met again at the University of Colorado with many recruits and completed a set of textbooks. Each of these was then tried out at about seventy experimental centers distributed throughout the United States. Consultants were available to help the teachers, but there was no special training to prepare teachers for using the materials. In fact, they had not seen the books until the week before the opening of school. This was also the case of the teachers in the 1959-60 study of the Minnesota National Laboratory. In addition to the textbooks for students, materials were also prepared for the use of teachers. These teacher guides go much further than is usual for such guides in discussing the mathematical background of the courses. SMSG has also promoted the preparation of a series of mathematics monographs designed for independent reading by superior students.

The SMSG student and teacher materials represent significant departures in a number of respects from the mathematics curriculums dominant at the time SMSG's work was instigated. Among the new emphases were the elimination of correction of mathematical fallacies, addition of mathematics theory, mastery of the skills of continued learning and the like. Some of the skills that Rosenbloom (1959) believes are given greater encouragement in these materials are the ability to generalize, ask good questions, recognize problems, invent new approaches, solve problems, and the like. He also believes that the materials have greater power to motivate learning and to develop interest in mathematics.

Studies conducted by the Educational Testing Service and by the Minnesota National Laboratory (SMSG Newsletter No. 10, November 1961) show that students in SMSG classes do about the same on the the traditional standardized tests as students in conventional classes on these tests. The study conducted by the Educational Testing Service indicated that students in SMSG classes learned substantial amounts of mathematics not included in conventional courses.

Evaluation Procedures

The testing program used in evaluating the outcomes of the SMSG materials in the Minnesota National Laboratory study was conducted under the direction of Edward O. Swanson, also the Director of the Minnesota Statewide Testing Program. In both the 1960-61 and the 1961-62 studies, the following time schedule was followed in the administration of the measures of aptitude and achievement:

Time	7th Gr.	8th Gr.	9th Gr.	10th Gr.	11th Gr.	12th Gr.
Fall	SCAT-V	SCAT-V	DAT-V	DAT-V	DAT-V	DAT-V
Fall	SCAT-Q	SCAT-Q	DAT-Q	DAT-Q	DAT-Q	DAT-Q
Fall	STEP(3A)	STEP(3A)	STEP(2A)	STEP(2A)	STEP(2A)	STEP(1A)
Spring	STEP(3B)	STEP(3B)	STEP(2B)	STEP(2B)	STEP(2B)	STEP(1B)

Key: SCAT, School and College Ability Tests; DAT, Differential Aptitude Tests; STEP, Sequential Tests of Educational Progress (in Mathematics); V, verbal part; Q, quantitative part.

All of these tests were prepared by the Educational Testing Service and are described and evaluated in a variety of sources.

In addition to the tests of achievement and aptitude listed above, there was a fall and spring administration of the Minnesota Student Attitude Inventory and a spring administration of the Student Checklist of Learning Activities in 1960-61 and a spring administration of a specially constructed attitude inventory in 1961-62.

In 1960-61, the participating teachers completed the Teacher and Pupil Activity Checklist for two lessons each week and at the end of each month completed one of the reports designed as a test of productive thinking. In 1961-62, they completed at the end of each month the reports on their most successful lesson, their least successful lesson, and ideas about alternative ways of teaching one of the mathematical concepts taught that month.

Descriptions of Instruments and Measures

The Minnesota Student Attitude Inventory

The Minnesota Student Attitude Inventory was developed over a period of about six years and was designed to provide a measure of student and teacher relationships conducive to learning. (See appendix for copy of Inventory.) The instrument had its origin in the Hoyt-Grim Pupil Attitude Inventory which was first used in some 1955-56 studies related to the development of the Minnesota Teacher Attitude Inventory. Item-analysis procedures on successive forms resulted in the 1960-61 form used in the present study. The form used in this study contains 59 items and students are asked to respond on a five-point scale. Items may be grouped into the following five clusters or scales:

1. Teacher Attractiveness
2. Fairness of Rewards and Punishments
3. Motivation and Interest
4. Independence
5. Disabling Anxiety.

The test-retest reliability of the Minnesota Student Attitude Inventory varies from class to class, ranging from .68 to .93, with a median reliability of .85. A high score on the Inventory is interpreted as a measure of the student's constructive attitudes toward the teacher and school work.

Daily Log of Teacher and Student Activities

The Daily Log of Teacher and Student Activities was developed by Torrance on the basis of his analyses of the open-ended teacher logs in 1958-59 and 1959-60. It represents an attempt to obtain through checklist form the same kind of data that the open-ended logs yielded. A successful attempt to achieve this goal would yield greater uniformity of data and provide greater ease of quantification. As will be observed from a sample copy of the checklist in the Appendix, attention is given to a wide range of mental operations as reflected in such teacher activities as:

1. Assigned homework, outside class activities, etc.
2. Explanation of new material
3. Conduct of learning and thinking activities of previously assigned material
4. Evaluation of pupil achievement
5. Use of special teaching aids.

A variety of mental operations were also listed under each of the following general categories of student activity:

1. Evidence of interest, motivation, curiosity
2. Evidence of learning
3. Evidence of thinking.

For each lesson analyzed by means of the checklist, teachers were also asked to describe any particular learning difficulty experienced by students and to tell how they tried to cope with the problem. Comments and evaluations concerning the SMSG materials involved in the lesson were also invited.

Productive Thinking Problems

A measure of productive thinking was based on responses to the following nine problems, one administered at the end of each month:

1. Please select one of your most successful lessons this month and describe in detail what you think made this lesson so successful. You may include things that you did, things that pupils did, or any aspect of the total conditions for learning and thinking. What do you consider the most important aims of this lesson? What indications did you have that the lesson was successful? What actions, events, conditions, materials, etc. do you think contributed most to the success of this lesson?

2. Please select one of your most unsuccessful lessons this month and describe in detail what you think made this lesson so unsuccessful. You may include your own activities, pupil activities, or any aspect of the total conditions for learning and thinking. What do you consider the most important aims of this lesson? What indications did you have that the lesson was unsuccessful? What actions, events, conditions, materials, etc. do you think contributed to the lack of success of this lesson?

3. Please list the most persistent and recurrent learning difficulties your pupils have experienced this month. Then pick out the learning difficulty that bothers you most. In the spaces provided below list whatever hypotheses you have concerning the causes of this difficulty and what can be done to reduce this difficulty in this or other similar classes.

4. Please select some concept in mathematics that you have taught during the current term and then try to think of as many ways as you can for introducing this concept. After this, please answer the following questions as completely as you can: What concept did you select? How did you introduce this concept? With what other methods for introducing this concept are you familiar? What other methods for introducing this concept do you think might be successful?

5. What techniques or strategies have you used during the current month to motivate your pupils to learn and to think more effectively in this course? What other techniques or strategies might have been equally more effective? You may include any scheme, device, requirement, assignment, reward, rule, or the like that you think might possibly be successful.

6. As you have taught this and possibly other SMSG courses you have probably felt that existing tests and types of tests do not give your pupils a chance to demonstrate their achievement on some of your most important objectives. Try to think of as many test ideas as you can for assessing some of the kinds of achievement in learning and thinking not now in use. In one section, list test ideas which involve modifications of traditional kinds of tests (tests of computational skills, problems, multiple-choice, true-false, completion, and the like). In the second section, list other test ideas.

7. List below all of the problems which you can think of that might arise in initiating SMSG mathematics courses throughout your school at all grade levels.

8. Many times during the current school term you have probably felt frustrated because your classroom was not suitable for some activity that would have stimulated learning and thinking among your pupils. Try to think of all of the characteristics a classroom would have to possess to make it ideal for teaching your SMSG course. Do not be concerned about cost or whether it is now possible to construct such a classroom. In the space below, write a description detailing your ideal classroom for this course. It would help if you would draw a sketch or sketches of this classroom. Attach drawings and additional descriptive material, if needed.

9. What do you think would happen if SMSG courses in mathematics were to be adopted on a statewide basis in Minnesota three years hence? Consider both the immediate and long-range consequences. Consider any area in which you think such an event would have consequences.

Some of the problems were designed to provide a measure of how productive the teacher is in thinking of ideas relative to his work. Some were designed to test his ability to formulate a plan or idea and elaborate it. Most of them provided an opportunity to produce original ideas, to get away from the obvious and the commonplace.

In 1961-62, the checklist was eliminated. Instead, teachers were asked to fill out each month the forms developed for Problems 1, 2, and 4. The various indexes derived from these data will be described along with the presentation of the results in Chapter 5.

Student Checklist of Learning Activities

Near the end of the 1960-61 school term, the pupils of the participating teachers were asked to fill out a one-page checklist describing their own perception of the learning and thinking activities in which they engaged. The items were very much the same as the ones to which the teachers responded and centered around evidences of motivation, learning, and thinking. Where possible, a non-SMSG class at the same grade level taught by the same teacher was asked to complete this checklist also.

SMSG Student Attitude Inventory

Near the end of the 1961-62 school term, the pupils of the participating teachers were asked to fill out the specially-constructed SMSG Student Attitude Inventory according to a design similar to that employed the previous year for the Checklist of Learning Activities. The Inventory was constructed by Richard Dawson and consisted of 64 items clustered as follows:

Teacher and teaching methods (30 items)
Class as a group (10 items)
School in general (12 items)
Textbook material (12 items)

The reliabilities of the four categories of items are acceptably high, considering the nature of the items. Using Hoyt's methods of two-way analysis of variance with single observation per cell, they are as follows:

Scale	Reliability Coefficient	Reliability Coefficient for 30 Items (Spearman-Brown)
Teacher and Methods	.88	.88
Class as a Group	.79	.92
School in General	.85	.94
Textbook Material	.85	.94

Subjects responded to each item in terms of their degree of agreement or disagreement (strongly disagree, disagree, undecided, agree, and strongly agree).

Measures of Teacher-Student Interaction

As a part of the 1960-61 study, the classes of ten of the participating teachers were visited by observers. These observers, using a method developed by Flanders and under his direction, obtained measures of teacher-student interaction. Only a brief description of the interaction measures will be given here. A full description of the procedure can be found elsewhere (Flanders, 1960; Amidon and Flanders, 1963). The methods used in training observers and insuring reliability of observations are also described in these sources.

The observers recorded the type of statement made by the teacher or by the students during the class period. One of the classifications that can be made of these types of statements is that of "direct" statements and "indirect" statements. Indirect statements of a teacher are those by which the teacher accepts and encourages student ideas and feelings, or asks questions. Direct statements are those with which a teacher is presenting his own or an authority's ideas, is giving directions or commands, or is criticizing. Flanders has made frequent use of the ratio, I/D, of the number, I, of a teacher's statements classified as "indirect," to the number, D, of those classified as "direct." This ratio is computed for each of the ten teachers visited and observed in this study.

Selection of Criterion Groups

Several criteria have been considered in the determination of the criterion groups. One of these (*g*) is defined as the difference between the pre- and post-test achievement scores (STEP) and may be interpreted as the average gain of a teacher's class and theoretically reflects how much the average student learns. The second (*a*) is defined as the slope from the regression of the post-test on the pre-test of achievement. This index theoretically reflects whether the teacher teaches more to the lower students in a class (small value for *a*) or to the higher students in a class (large value of *a*). A third index (*max.*) is defined as the largest of the differences (d_1, d_2, d_3), where d_1 is the difference between the regression line of the post-test achievement score (STEP) on the aptitude score (SCAT or DAT) at approximately one standard deviation below the mean for the teacher's class; d_2 is the same but approximately at the mean; and d_3 is the same but at approximately one standard deviation above the mean. Theoretically, this index reflects how much a teacher teaches that part of the class that he seems to teach best.

The rank coefficients of correlation among these three measures of teacher effectiveness for participants in the 1960-61

Table 3.4

Rank Correlation Coefficients Among Three Measures of Teacher Effectiveness for Grades Seven Through Twelve, 1960-61

	Coefficient of Correlation		
Grade	g and a	g and max	a and max
Seven	.05	.80	-.20
Eight	.12	.85	.21
Nine	-.70	.89	-.48
Ten	-.04	.79	-.05
Eleven	-.13	.90	-.34
Twelve	.50	.80	.17

Note: *g* = Post-test (SCAT) — Pre-test (SCAT)
a = Slope from regression of Post-test on Pre-test
max. = Largest of (d_1, d_2, d_3), where d_1 = difference between the regression line of Post-test on Aptitude (SCAT or DAT) and the regression line of Post-test on Pre-test at approximately one standard deviation below the mean for the teacher's class. d_2 = same but at mean. d_3 = same but at approximately one standard deviation above the mean.

study by grades are shown in Table 3.4. It will be observed that there are uniformly high correlations between *g* (the mean gain) and *max*. (the index reflecting how well a teacher teaches that portion of the class that he seems to teach best). The coefficients of correlation between *a* (the slope from regression of post-test on pre-test) with the other two measures are inconsistent, generally low, and sometimes even negative.

Since some skepticism has been expressed regarding the use of *a* as an index of teacher effectiveness, the criterion groups for the present study were selected by combining the *g* and *max*. ranks and then taking the upper and lower thirds for each grade. Kraft, who served as statistical consultant for the project at this stage of development, states that he is reluctant to interpret *a* too literally. Abstractly this measure is the increase in post-test score per unit increase in pre-test scores. Kraft bases his skepticism on the belief that learning rate should be dependent upon the amount of pre-learning and not constant. He points out, further, that the teacher who concentrates on the lower half of a class at the expense of the upper half would have a low value for *a* and vice versa.

Although the basic analyses for both 1960-61 and 1961-62 have been made for criterion groups thus selected, from time to time information will be given concerning the characteristics or behaviors of those teachers high on *a* but low on *g* and *max*. In the process of reaching the above decision, arguments were advanced for a number of other methods of selecting the criterion groups. Carolyn Gitzen developed an index that takes into consideration the first, second, and third quartiles (Q_1, Q_2, and Q_3) and some analyses using this index will be reported. Gitzen developed this index when Kraft (1963) and others pointed out the difficulties resulting from the fact that some of the students in the study achieved scores that went off the top on the pre-test of achievement (STEP). This obviously limits the value of using the mean gain as an index of teacher effectiveness, since such students could not possibly make a gain on the particular set of tests given. By using the three points (Q_1, Q_2, and Q_3), Gitzen hoped to have the index weighted by a moderately wide range rather than merely reflecting what the teacher did with the average student. At the same time, she hoped to avoid the two extremes -- those students who made very little gain (usually the superior students who were at or near the ceiling on the pre-test and went off the top on the post-test) and those who made excessively large gains (some being so excessive that it is probable that the student misunderstood the instructions or was not motivated to perform well on the pre-test). The same was true in reverse for those who made unbelievably lower scores on the post-test than on the pre-test. To compute this index, a modified median was obtained by computing the mean of the Q_1 plus Q_2 plus Q_3. Then a Z score was computed according to the following formula: Modified Median minus Mean of the Median Gain of All Classes in Grade divided by the Standard Deviation of the Median Gains. The Z scores were then arranged in order and the most and least effective teachers according to this criterion were selected.

Chapter 4

RESULTS OF THE 1960-61 STUDY

The results of the 1960-61 study will be reported in this chapter and those for the 1961-62 study in Chapter 5. It is believed that this procedure will present a less confusing picture than attempting to report both studies simultaneously. There were slight variations in some of the procedures used in characterizing teachers and there were some losses in the number of teachers who completed the 1960-61 study. In most instances, results will be reported for each of two sets of criteria of teacher effectiveness. Much serious consideration, many hours of discussion among project personnel, and much exploratory work went into the decision concerning which set of criteria to use. As will be seen, however, the two sets of criteria produced practically no differences in results. Furthermore, there were only three teachers selected by the more restrictive Criterion 1 (upper and lower thirds on a combination of g and max.) and the more inclusive Criterion 2 (upper and lower halves on the modified median gain from pre-test to post-test of achievement).

The criteria labeled g (mean gain in mathematics achievement from pre-test to post-test), a (slope from regression line of post-test on pre-test), and max. (largest difference between regression line of post-test on aptitude at points on the mean, one standard deviation below the mean, and one standard deviation above the mean) were developed by the statistical staff of the larger project. In the original proposal, it was planned to compare the upper and lower thirds at each grade level as determined by these criteria. Then, for the reasons discussed in the previous chapter, a criterion based on the modified median was developed by Gitzen working on the staff of the thinking characteristics subproject and used by her and Gupta in analyzing the data on the thinking characteristics of the teachers. In preparing the final report, however, Torrance and Parent went back to the originally proposed criteria and reanalyzed the data.

Criterion 1 is based on a combination of ranks derived from the indexes labelled g and max. Ranks based on these two indexes were added and then teachers at each grade level were reranked. The "most effective" group consists of those teachers ranking in the upper third at each grade level and the "least effective" group consists of those ranking on the lower third of these combined ranks. Torrance and Parent defend this decision on two bases. First, it will be recalled that g and max. are consistently and highly correlated with one another. Their correlation with a, however, is not consistent from grade to grade. Second, what is presumably reflected in these indexes is more clearly an indication of teacher effectiveness as assessed by pupil learning than what is presumably reflected in the index labeled a. This argument has been reviewed in Chapter 3.

Criterion 2 is based on the Z scores developed from the modified median gains in mathematics achievement. Here, the "most effective" group consists of those who ranked in the upper half at each grade level on this criterion and the "least effective" group is composed of those ranking in the lower half.

Productive Thinking of Teachers

One of the major thrusts of this study was to develop reporting forms that might in effect provide a measure of the creative thinking abilities and motivations of mathematics teachers, or more properly, as it turned out, a measure of productive thinking. As outlined in the previous chapter, this measure of productive thinking is a count of the number of constructive, potentially useful ideas produced by the teachers in response to the nine problems, one given each month at the end of the log book. It is recognized, of course, that many mental, personality, and motivational characteristics enter into this index. Some teachers were careless and did not bother to respond to the problem after completing the log book. Some of them responded with what would appear to be the least expensive energy possible. Still others apparently put a great deal of creative energy into their responses, permitted their creative thinking processes to focus on these problems, and communicated the results of their thinking through their monthly reports. It is to be expected, however, that these characteristics will also be reflected in the teaching effectiveness of the subjects.

Adequate data were available for 18 of the "most effective" teachers and 15 of the "least effective" ones on Criterion 1 and for 31 of the "most effective" and 29 of the "least effective" on Criterion 2. The comparisons of the productive thinking scores for the criterion groups are presented in Table 4.1 It will be noted that regardless of the criterion used, the "most effective" group achieved a significantly higher score than the "least effective" group at better than the one percent level of confidence. Both in terms of actual differences and in terms of level of significance, these results are quite impressive, In both cases the "most effective" teachers produced about twice as many ideas as their less effective colleagues. Somewhat limiting is the fact that the variability among the "most effective" teachers is

Table 4.1

Means and Standard Deviations of Productive Thinking Scores of the Most and Least Effective 1960-61 Teachers According to Two Criteria of Effectiveness and Tests of Significance

	Most Effective			Least Effective				Level
Criterion	Number	Mean	St. Dev.	Number	Mean	St. Dev.	t-ratio	Sig.
Criterion 1 (*g* and *max.*)	18	60.6	30.55	15	28.1	13.66	3.80	<.01
Criterion 2 (Modified Median)	31	56.7	29.67	29	28.8	16.13	4.48	<.01

quite high, much higher than among the "least effective" ones. This phenomenon seems to have resulted from the fact that some of the "most effective" teachers submitted only a small number of their problems while others submitted all of theirs and were generally quite productive. Some of the "least effective" teachers also failed to submit some of their problems while others submitted all of theirs. Since the latter group tended to be relatively unproductive there was not the unusually high variation within that group that we find in the "most effective" group. It is quite probable that failure to respond and/or submit all of the problems had different meanings for these two groups of teachers. For the highly effective teacher it may not reflect low productive thinking ability but rather an absorption in other teaching problems and the expenditure of creative energy on these problems rather than the ones presented as a part of the log books.

Energy Spent in Preparation for Teaching

It is reasonable to expect that the amojnt of energy spent by a teacher in preparation for teaching will be reflected in the amount of learning that occurs among students. One way of assessing this characteristic is to determine the amount of time devoted to this preparation. It must be recognized, of course, that much of the "payoff" in teaching is likely to come during periods of incubation after one has made this formal preparation but continues to think about the problems while doing other things like eating, shaving, bathing, sitting in church, and the like. Nevertheless, each of the daily logs completed by the subjects of this study called for an estimate of the amount of time in minutes spent on the SMSG material and the amount of time devoted to other materials and asked whether the teacher felt the need for more training in order to teach that particular lesson.

The results of the analysis of these data are reported in Tables 4.2 and 4.3. It will be noted that although all of the

Table 4.2

Comparison of Amount of Time Spent in Preparation for Teaching and Recognition of Own Need for More Training of Most and Least Effective 1960-61 Teachers According to Criterion One

Measure	Most Effective			Least Effective				Level
	No.	Mean	St. Dev.	No.	Mean	St. Dev.	t-ratio	Sig.
Time in minutes on SMSG Material	18	47.9	38.28	15	46.2	27.36	0.03	NS
Time in minutes on Other Materials	18	11.6	26.36	15	8.3	10.35	0.45	NS
Percentage of Time Recognized Need for More Training	18	.63	.31	15	.58	.29	0.46	NS

Table 4.3

Comparison of Time Spent in Preparation for Teaching and Recognition of Own Need for More Training of Most and Least Effective 1960-61 Teachers According to Criterion Two

Measure	Most Effective			Least Effective				Level
	No.	Mean	St. Dev.	No.	Mean	St. Dev.	t-ratio	Sig.
Time in Minutes on SMSG Material	31	44.8	31.23	29	42.7	24.69	0.28	NS
Time In Minutes on Other Material	31	10.6	20.55	29	8.6	10.97	0.49	NS
Proportion of Time Recognized Need for More Training	31	.63	.28	29	.57	.33	0.81	NS

differences are in favor of the "most effective" teachers, all of them are extremely small and none of them even approach statistical significance. Although there is no way of knowing how much time was "actually" spent on thinking about the materials being taught, one can guess that the difference lies here instead of in the amount of time deliberately and measureably spent. It is interesting, however, to observe that the teachers in the study devoted about one hour to the preparation of each lesson covered by their logs and that in about 60 percent of the cases there was an expression of a need for more training in mathematics.

Experience and Educational Qualifications

The above results bring us back to a reconsideration of the traditionally accepted teacher qualifications of teaching experience, courses, and grades. It will be recalled that prior to the initiation of the present study, mathematics teachers throughout the state of Minnesota had been invited to submit applications for participation in the field testing of the SMSG materials. These application blanks called for information concerning length of experience teaching mathematics, undergraduate and graduate mathematics courses and grades, and professional contributions. In addition, official transcripts were obtained. In selecting the original group of 127 participants, applicants were stratified on the basis of an index made up of these criteria and a random sample drawn from each stratum.

A comparison of the means of the most and least effective teachers on the five criteria derived from the applications is presented in Table 4.4. It will be noted that the most effective teachers are characterized by greater length of mathematics teaching experience and lower scores on the index of undergraduate courses and grades in mathematics. No statistically significant differences are observed for the other three qualifications nor for the Total Qualification Index.

Since the means on mathematics teaching experience and undergraduate and graduate courses and grades were unduly influenced by unusually high scores by a small number of subjects, it was decided to run tests of differences based on the median. The results of these analyses are presented in Table 4.5. From these data it will be observed that none of the differences are statistically significant. The same trend as observed in Table 4.4 is found for amount of mathematics teaching experience but there is a slight reversal for undergraduate mathematics courses and grades. Thus, we see again that amount of teaching experience and courses and grades do not play very dominant roles in teacher effectiveness.

Table 4.4

Comparison of Means of Experience and Education Variables of Most and Least Effective 1960-61 Teachers According to Criterion One

Variable	Most Effective			Least Effective				Level
	No.	Mean	St. Dev.	No.	Mean	St. Dev.	t-ratio	Sig.
Length of Experience Teaching Mathematics	24	56.3	21.5	25	37.8	20.1	3.07	$<.01$
Undergraduate Grades and Courses in Mathematics	24	88.8	37.7	25	106.7	37.8	-3.33	$<.01$
Graduate Courses and Grades in Mathematics	24	42.7	41.7	25	51.5	46.1	0.69	NS
Participation in Mathematics Organizations	24	46.7	36.7	25	45.0	30.8	0.17	NS
Professional Contributions	24	17.3	69.3	25	9.2	17.6	0.56	NS
Total Qualification Index	24	253.2	119.8	25	250.2	78.5	0.10	NS

It must be recognized, of course, that certain minimum requirements had to be met by each teacher and that there was motivation to participate in the field testing of the SMSG materials.

Table 4.5

Tests for Differences in Medians Between Most and Least Effective 1960-61 Teachers According to Criterion 1 on Experience and Education Variables

Mathematics Teaching Experience

	Most Effective	Least Effective	Total
Above Median	15	9	24
Below Median	10	15	25
Total	25	24	49

Median = 32.1; X^2 = 1.6619; Not Significant

Undergraduate Mathematics Courses and Grades

	Most Effective	Least Effective	Total
Above Median	14	11	25
Below Median	11	13	24
Total	25	24	49

Median = 96.8; X^2 = 0.181; Not Significant

Graduate Mathematics Courses and Grades

	Most Effective	Least Effective	Total
Above Median	15	10	25
Below Median	10	14	24
Total	25	24	49

Median = 33.6; X^2 = .9950; Not Significant

Professional Organizations

	Most Effective	Least Effective	Total
Above Median	13	12	25
Below Median	12	12	24
Total	25	24	49

Median = 36.3; X^2 = .0212; Not Significant

Procedures in Making Assignments

It is generally assumed that one of the important roles of the teacher is to structure properly the learning experiences of their pupils through the assignments that they give for homework and outside of class activities. It was also thought that the procedures used by a teacher in making assignments will reflect his own thinking characteristics. The daily logs submitted for approximately eight lessons each month called for estimates on each of eight assignment procedures listed in Tables 4.6 and 4.7.

Table 4.6

Comparison of Procedures in Assigning Homework and Outside Class Activities of Most and Least Effective 1960-61 Teachers, According to Criterion 1

	Most Effective			Least Effective				Level of
Teacher Activity	No.	Mean	S. Dev.	No.	Mean	S. Dev.	t-ratio	Significance
Assigned problems from textbook	18	1.19	0.37	15	0.96	.80	1.10	≅.25
Assigned problems from supplementary sources	18	0.12	0.11	15	0.09	.11	0.75	≅.45
Assigned original problems of teacher	18	0.20	0.21	15	0.15	.17	0.71	≅.45
Assigned problems requiring convergent solutions	18	0.86	0.59	15	0.67	.34	1.12	≅.25
Assigned problems requiring divergent solutions	18	0.27	0.36	15	0.23	.18	0.90	≅.35
Assigned problems requiring applications	18	0.83	0.57	15	0.65	.33	0.19	≅ NS
Assigned problems requiring discovery of rule or principle	18	0.24	0.22	15	0.23	.17	0.14	≅ NS
Assigned sustained project requiring 3 or more days	18	0.10	0.16	15	0.07	.13	0.60	≅ NS

The teacher was asked to indicate by a single check if he engaged in the activity at least once during the lesson and by a double check if he engaged in the activity continuously or three or more times. The means reported in Tables 4.6 and 4.7 are means of the number of checks per log. If we use Criterion 1 as the measure of teacher effectiveness, we observe a trend for the more effective teachers more frequently and/or consistently to assign problems from the textbook and to assign convergent thinking problems. The differences, however, are significant at only about the 25 percent level of confidence.

Table 4.7

Comparison of Procedures in Assigning Homework and Outside Class Activities of Most and Least Effective 1960-61 Teachers, According to Criterion 2

	Most Effective			Least Effective				Level
Teacher Activity	No.	Mean	S. Dev.	No.	Mean	S. Dev.	t-ratio	Sig.
Assigned problems from textbook	31	1.15	0.35	29	0.95	0.23	2.57	$<.02$
Assigned problems from supplementary sources	31	0.14	0.13	29	0.11	0.14	0.66	NS
Assigned original problems by teacher	31	0.22	0.20	29	0.21	0.27	0.19	NS
Assigned problems requiring convergent solutions	31	0.88	0.56	29	0.66	0.32	1.93	$\cong .06$
Assigned problems requiring divergent solutions	31	0.33	0.43	29	0.22	0.18	1.29	$<.20$
Assigned problems requiring applications	31	0.86	0.51	29	0.62	0.37	2.05	$<.05$
Assigned problems requiring discovery of rule or principle	31	0.28	0.28	29	0.49	1.47	-0.81	$\cong .40$
Assigned sustained project requiring 3 or more days	31	0.09	0.13	29	0.08	0.13	0.48	NS

If we use Criterion 2 as the basis for designating more and less effective groups and use these data for all 60 of the participants for whom there are complete data, these two trends become statistically significant at the .02 and .06 levels of confidence respectively. Differences regarding the assignment of application problems in favor of the more effective teachers is also significant at better than the .05 level of confidence. A general inspection of these two tables gives something more than a slight hint that the more effective teachers give their pupils a greater amount of structure than do the less effective ones. There is even a slight trend for the less effective teachers more frequently than their more effective colleagues to assign learning experiences requiring the discovery of rules and principles.

Explaining New Materials

There were hints in the teacher logs for 1958-59 and 1959-60 that teachers differed in the procedures used in explaining new materials and that this differentiated the most and least effective ones. Consequently, the five procedures listed in Tables 4.8 and 4.9 were included in the log checklist. The reporting procedures and the method of obtaining mean scores was the same as reported for assignment procedures. The results obtained on the basis of Criterion 1 are reported in Table 4.8 and those on the basis of Criterion 2 are shown in Table 4.9. It will be seen that the criterion groups do not differ significantly on any of these five procedures. With Criterion 2, using data from all 60 subjects supplying complete predictor and criterion data, there is a fairly marked trend for the more effective teachers more frequently and/or consistently than their less effective colleagues to follow routinely the text or teacher commentary and to try out the special devices suggested by the SMSG materials. Again, there is a slight hint that the more effective teachers have a greater concern for structure than have the less effective ones. At the same time, they make fully as much use of originally developed devices as do the less effective ones.

Table 4.8

Comparison of Procedures in Explaining New Material of Most and Least Effective 1960-61 Teachers, According to Criterion 1

Teacher Activity	Most Effective			Least Effective			t-ratio	Level Sig.
	No.	Mean	S. Dev.	No.	Mean	S. Dev.		
Routinely followed text or teacher commentary	18	0.95	0.52	15	0.82	0.20	0.17	NS
Used special device suggested by SMSG materials	18	0.20	0.20	15	0.14	0.83	0.30	NS
Used special device adapted from other source	18	0.13	0.17	15	0.11	0.51	0.15	NS
Used originally developed device or procedure	18	0.35	0.23	15	0.33	0.28	0.22	NS
Made quick test (question, problem) to test for comprehension	18	0.28	0.31	15	0.22	0.41	0.50	NS

Table 4.9

Comparison of Procedures in Explaining New Material of Most and Least Effective 1960-61 Teachers, According to Criterion 2

Teacher Activity	Most Effective			Least Effective			t-ratio	Level Sig.
	No.	Mean	S. Dev.	No.	Mean	S. Dev.		
Routinely followed text or teacher commentary	31	0.91	0.45	29	0.77	0.24	1.39	≅.15
Used special device suggested by SMSG material	31	0.19	0.19	29	0.12	0.18	1.40	≅.15
Used special device adapted from other source	31	0.15	0.19	29	0.18	0.20	-0.52	NS
Used originally developed device or procedure	31	0.36	0.29	29	0.33	0.27	0.45	NS
Made quick test (question, problem) to test for comprehension	31	0.31	0.30	29	0.26	0.36	0.57	NS

Conducting Learning and Thinking Experiences

On the basis of his experience in analyzing the logs from the first two years of experimentation, Torrance hypothesized that the procedures teachers use in conducting learning and thinking experiences of previously assigned material reflects the thinking characteristics of the teacher and makes a difference in effectiveness. Accordingly, the nine procedures listed in Table 4.10 and 4.11 were incorporated into the log checklist.

Table 4.10

Comparison of Procedures in Conducting Learning and Thinking Activities of Previously Assigned Materials of Most and Least Effective 1960-61 Teachers, According to Criterion One

	Most Effective			Least Effective				Level
Teacher Activity	No.	Mean	S. Dev.	No.	Mean	S. Dev.	t-ratio	Sig.
Answered pupil questions	18	1.33	0.49	15	1.09	.41	1.50	≅.15
Gave correct solution to problem(s)	18	1.12	0.48	15	0.67	.45	2.81	<.01
Stimulated pupil(s) to find solution	18	0.84	0.46	15	0.85	.41	-0.07	NS
Asked pupil(s) to reproduce previously presented ideas, information	18	0.79	0.46	15	0.64	.38	1.00	≅.35
Had pupils present solutions to problems at blackboard	18	0.53	0.34	15	0.57	.39	-0.31	NS
Stimulated competition within class	18	0.38	0.39	15	0.28	.31	0.83	≅.40
Had pupils to work in pairs or other small groups	18	0.22	0.46	15	0.17	.20	0.39	NS
Gave alternative or divergent solutions	18	0.35	0.28	15	0.35	.20	0.00	NS
Stimulated pupil(s) to find alternative or divergent solutions	18	0.29	0.30	15	0.37	.23	-0.89	≅.40

Table 4.11

Comparison of Procedures in Conducting Learning and Thinking Activities of Previously Assigned Materials of Most and Least Effective 1960-61 Teachers, According to Criterion Two

	Most Effective			Least Effective				Level
Teacher Activity	No.	Mean	S. Dev.	No.	Mean	S. Dev.	t-ratio	Sig.
Answered pupil questions	31	1.33	0.49	29	1.23	0.37	0.85	≅.40
Gave correct solution to problem(s)	31	1.05	0.53	29	0.81	0.43	1.89	≅.06
Stimulated pupil(s) to find solution	31	0.92	0.45	29	0.89	0.39	0.32	NS
Asked pupil(s) to reproduce previously presented ideas, information	31	0.81	0.46	29	0.75	0.43	0.52	NS
Had pupils present solutions to problems at blackboard	31	0.57	0.38	29	0.60	0.45	-0.34	NS
Stimulated competition within class	31	0.41	0.42	29	0.36	0.40	0.44	NS
Had pupils to work in pairs or other small groups	31	0.24	0.40	29	0.24	0.33	-0.01	NS
Gave alternative or divergent solutions	31	0.39	0.35	29	0.40	0.27	-0.10	NS
Stimulated pupil(s) to find alternative or divergent solutions	31	0.36	0.37	29	0.35	0.24	0.07	NS

On both Criterion 1 and Criterion 2, the more effective teachers seem more frequently and/or consistently than the less effective ones to give correct solutions to problems. There is also a slight tendency for this same trend to persist regarding the matter of answering pupil questions. None of the other measures, however, produce any consistent and/or statistically significant differences.

Evaluation Procedures

One of the strongest findings in Torrance's (1965) earlier analysis of teacher logs had to do with the teacher's thinking as reflected in his evaluative behavior. Using these leads, he included in the 1960-61 log checklist the seven evaluation procedures listed in Tables 4.12 and 4.13. Using Criterion 1 as the indicator of teacher effectiveness, we find trends on four of the indicators that offer some promise: pointing out defects in pupil solutions, pointing out other approaches and solutions, analyzing causes of errors or failure to solve problems, and praising pupils for correct solutions, all in favor of the more effective teachers. Again, we find a hint that the more effective teachers more frequently and consistently give their pupils structure and let them know what the teachers expect of them. There is a very slight tendency for the less effective teachers to rely more

Table 4.12

Comparison of Evaluation Procedures of Most and Least Effective 1960-61 Teachers, According to Criterion One

Teacher Activity	Most Effective			Least Effective			t-ratio	Level Sig.
	No.	Mean	S. Dev.	No.	Mean	S. Dev.		
Gave test or check quiz	18	0.21	0.18	15	0.23	0.40	-0.29	NS
Discussed or analysed test results	18	0.15	0.18	15	0.18	0.17	-0.50	NS
Pointed out defects in pupil solution(s)	18	0.76	0.42	15	0.51	0.41	1.67	<.10
Pointed out other approaches or solutions	18	0.50	0.36	15	0.39	0.26	1.00	≦.30
Analyzed causes of errors or failure to solve problems	18	0.65	0.36	15	0.53	0.36	1.00	≦.30
Praised pupil for correct solution	18	0.76	0.53	15	0.56	0.49	1.11	≦.30
Praised pupil for original solution or idea	18	0.19	0.20	15	0.18	0.14	0.20	NS

Table 4.13

Comparison of Evaluation Procedures of Most and Least Effective 1960-61 Teachers, According to Criterion Two

Teacher Activity	Most Effective			Least Effective			t-ratio	Level Sig.
	No.	Mean	S. Dev.	No.	Mean	S. Dev.		
Gave test or check quiz	31	0.24	0.21	29	0.26	0.23	-0.31	NS
Discussed or analyzed test results	31	0.19	0.22	29	0.22	0.22	-0.63	NS
Pointed out defects in pupil solution(s)	31	0.69	0.45	29	0.58	0.42	0.97	≅.35
Pointed out other approaches or solutions	31	0.48	0.39	29	0.42	0.30	0.61	NS
Analyzed causes of errors or failure to solve problems	31	0.58	0.39	29	0.52	0.42	0.55	NS
Praised pupil for correct solution	31	0.68	0.52	29	0.58	0.48	0.70	≅.50
Praised pupil for original solution or idea	31	0.20	0.21	29	0.20	0.20	0.00	NS

heavily on tests and their analysis than is true of the more effective ones. The differences are too small to be meaningful except in contrast to the other trends shown in Tables 4.12 and 4.13.

Evidences of Interest, Motivation, and Curiosity

Torrance's analysis of the 1958-59 and 1959-60 teacher logs suggested that there is a relationship between the interest, motivation, and curiosity of students and the patterns of thinking of their teachers. Thus, the eight indications of interest, motivation, and curiosity listed in Tables 4.14 and 4.15 were incorporated into the checklist used in 1960-61. It will be seen from these two tables that only the two items on asking questions show even a consistent trend for both criteria and all of these differences are too small to be of a great deal

Table 4.14

Comparison of Evidence of Interest, Motivation, and Curiosity Reported by Most and Least Effective 1960-61 Teachers, According to Criterion One

Pupil Activity	Most Effective			Least Effective			t-ratio	Level Sig.
	No.	Mean	S. Dev.	No.	Mean	S. Dev.		
Evidenced having studied assigned material	18	1.79	0.71	15	1.73	0.62	0.25	NS
Evidenced having read or studied unassigned material	18	0.27	0.26	15	0.28	0.26	0.11	NS
Evidenced having discussed work outside class	18	0.86	0.53	15	0.73	0.42	0.81	≅.40
Asked question(s) that indicated curiosity	18	1.20	0.53	15	1.07	0.26	0.87	≅.40
Asked question(s) that indicated learning difficulty	18	1.19	0.63	15	0.97	0.34	1.22	≅.20
Took notes on lectures, etc.	18	0.93	0.80	15	0.72	0.66	0.81	≅.40
Aggressively kept trying to understand, solve, etc.	18	1.17	0.65	15	1.09	0.74	0.32	NS
Became frustrated; gave up trying to understand, etc.	18	0.29	0.35	15	0.26	0.25	0.28	NS

of interest. Using Criterion 1, there are weak trends in favor of the most effective teachers for reports of evidences of students' having discussed their work outside class and for taking notes on lectures and other classroom activities.

Table 4.15

Comparison of Evidence of Interest, Motivation, and Curiosity Reported by Most and Least Effective 1960-61 Teachers, According to Criterion Two

Pupil Activity	Most Effective No.	Most Effective Mean	Most Effective S. Dev.	Least Effective No.	Least Effective Mean	Least Effective S. Dev.	t-ratio	Level Sig.
Evidenced having studied assigned material	31	1.84	0.74	29	1.76	0.61	0.43	NS
Evidenced having read or studied unassigned material	31	0.35	0.37	29	0.31	0.27	0.55	NS
Evidenced having discussed work outside class	31	0.91	0.54	29	0.90	0.49	0.07	NS
Asked question(s) that indicated curiosity	31	1.30	0.54	29	1.20	0.48	0.77	≅.45
Asked question(s) that indicated learning difficulty	31	1.12	0.50	29	0.96	0.47	1.21	≅.20
Took notes on lectures, etc.	31	0.96	0.77	29	0.87	0.78	0.42	NS
Aggressively kept trying to understand, solve, etc.	31	1.10	0.60	29	1.16	0.71	-0.35	NS
Became frustrated; gave up trying to understand, etc.	31	0.33	0.41	29	0.27	0.31	0.47	NS

Evidences of Student Learning

On the rationale that the kinds of evidences of learning and thinking that teachers recognize is related to how much students learn and apply their learning, the eight indicators listed in Tables 4.16 and 4.17 were developed for the 1960-61 checklist. As will be noted from these two tables, there are no really strong and consistent trends for any of the indicators. The direction of the differences is consistent, however, for the two criteria.

Table 4.16

Comparison of Evidences of Learning Reported by Most and Least Effective 1960-61 Teachers, According to Criterion One

	Most Effective			Least Effective				Level
Pupil Activity	No.	Mean	S. Dev.	No.	Mean	S. Dev.	t-ratio	Sig.
Reproduced previously presented ideas, solutions	18	1.30	0.69	15	1.13	0.41	0.85	≅.40
Used newly acquired vocabulary	18	1.29	0.65	15	1.21	0.39	0.42	NS
Recognized correct principle for solving problem	18	1.19	0.62	15	1.22	0.45	-0.16	NS
Solved new problems similar to ones explained	18	1.04	0.55	15	1.09	0.50	-0.26	NS
Helped fellow pupils solve problems, etc.	18	0.63	0.33	15	0.65	0.34	-0.17	NS
Organized information, ideas, etc. into optimal sequence	18	0.30	0.47	15	0.29	0.36	0.07	NS
Identified errors or defects of classmate's solution	18	0.55	0.31	15	0.53	0.38	0.17	NS
Identified errors or defects in solution by teacher, text, etc.	18	0.14	0.13	15	0.22	0.15	-1.60	≅.10

The more effective teachers more frequently and consistently than the less effective ones reported the reproduction of previously learned ideas and solutions and the use of new vocabulary and less frequently and consistently reported correct recognition of principles, the solution of new problems similar to previously explained ones, helping fellow pupils solve problems, and the identification of errors or defects in the solutions by the teacher, text, or other authority.

Table 4.17

Comparison of Evidences of Learning Reported by Most and Least Effective 1960-61 Teachers, According to Criterion Two

Pupil Activity	Most Effective			Least Effective			t-ratio	Level Sig.
	No.	Mean	S. Dev.	No.	Mean	S. Dev.		
Reproduced previously presented ideas, solutions	31	1.36	0.75	29	1.34	0.56	0.10	NS
Used newly acquired vocabulary	31	1.34	0.72	29	1.25	0.48	0.56	NS
Recognized correct principle for solving problems	31	1.23	0.63	29	1.27	0.52	-0.25	NS
Solved new problems similar to ones explained	31	1.07	0.62	29	1.13	0.55	-0.41	NS
Helped fellow pupils solve problems, learn new material	31	0.68	0.46	29	0.72	0.41	-0.38	NS
Organized information, ideas, etc. into optimal sequence	31	0.40	0.52	29	0.40	0.42	0.00	NS
Identified errors or defects of classmate's solution	31	0.62	0.42	29	0.67	0.49	-0.38	NS
Identified errors or defects in solution by teacher, text, etc.	31	0.20	0.22	29	0.22	0.21	-0.50	NS

Evidences of Thinking

Twelve different evidences of pupil thinking were included in the 1960-61 checklist and are listed in Tables 4.18 and 4.19.

Table 4.18

Comparison of Evidences of Thinking Reported by Most and Least Effective 1960-61 Teachers, According to Criterion One

	Most Effective			Least Effective				
Pupil Activity	No.	Mean	S. Dev.	No.	Mean	S. Dev.	t-ratio	Level Sig.
Discovered relationship between two ideas, concepts, etc.	18	0.95	0.71	15	0.86	0.50	0.41	NS
Discovered complex relationship in pattern or system of symbols	18	0.38	0.47	15	0.31	0.33	0.47	NS
Visualized what a pattern or set of relationships would look like if rearranged	18	0.36	0.48	15	0.40	0.45	0.59	NS
Explored visually several solutions, courses of action, etc.	18	0.41	0.28	15	0.38	0.26	1.00	≅.35
Saw beyond the immediate and obvious	18	0.55	0.50	15	0.36	0.26	1.27	≅.20
Produced diversity of possible solutions, applications, etc.	18	0.16	0.24	15	0.17	0.15	0.08	NS
Abandoned conventional approach and thought of original solution	18	0.18	0.17	15	0.12	0.10	0.27	NS
Produced clever or uncommon responses	18	0.15	0.17	15	0.15	0.17	0.00	NS
Worked out details to develop a general idea	18	0.20	0.04	15	0.17	0.28	0.23	NS
Suggested a symbol that will satisfy a given relationship	18	0.04	0.07	15	0.06	0.14	-1.43	≅.15
Used a principle, object, concept, etc. in a new way	18	0.08	0.11	15	0.10	0.20	-4.00	<.01
Suggested improved or new way of working, functioning as a class, etc.	18	0.03	0.07	15	0.02	0.10	0.33	NS

Table 4.19

Comparison of Evidences of Thinking Reported by Most and Least Effective 1960-61 Teachers, According to Criterion Two

Pupil Activity	Most Effective			Least Effective			t-ratio	Level Sig.
	No.	Mean	S. Dev.	No.	Mean	S. Dev.		
Discovered relationship between two ideas, concepts, etc.	31	1.07	0.72	29	1.03	0.55	0.26	NS
Discovered complex relationship in pattern or system of symbols	31	0.46	0.51	29	0.38	0.33	0.67	NS
Visualized what a pattern or set of relationships would look like if rearranged	31	0.49	0.55	29	0.48	0.42	0.09	NS
Explored visually several solutions, courses of action, etc.	31	0.54	0.42	29	0.50	0.40	0.35	NS
Saw beyond the immediate and obvious	31	0.57	0.47	29	0.51	0.42	0.47	NS
Produced diversity of possible solutions, applications, etc.	31	0.29	0.32	29	0.23	0.19	0.93	≅.35
Abandoned conventional approach and thought of original solution	31	0.24	0.26	29	0.18	0.23	0.94	≅.35
Produced clever or uncommon responses	31	0.22	0.27	29	0.23	0.24	0.05	NS
Worked out details to develop a general idea	31	0.30	0.42	29	0.28	0.37	0.24	NS
Suggested a symbol that will satisfy a given relationship	31	0.12	0.24	29	0.08	0.12	0.78	≅.40
Used a principle, object, concept, etc. in a new way	31	0.17	0.29	29	0.17	0.18	0.06	NS
Suggested improved or new way of working, functioning as a class, etc.	31	0.08	0.17	29	0.02	0.03	1.91	≅.06

These data show no consistent differences of any magnitude on the two sets of criteria used. One possibility is that so few evidences of student thinking were reported that this kind of behavior appeared too infrequently to make much difference. Another possibility is that the kinds of mental functioning involved in these kinds of student activities does not have a very powerful influence on the kinds of achievement measured by the tests of achievement used in this study. Since the test items do not involve productive thinking in the strictest sense, both of these possible explanations seem fairly plausible.

Student Perception of Learning and Thinking Activities

The kinds of observations that teachers have to make in order to guide learning effectively are always complex. The kinds of observations called for by the log checklist are exceptionally complex and it is perhaps unreasonable to expect teachers to report accurately observations of the learning and thinking activities of their students as a group. There are also great individual differences within a class in the kinds of learning and thinking activities that occur. Thus, the students of the subject teachers were asked in the spring of 1961 to fill out a one-page checklist giving their own perceptions of evidences of their interest, motivation, learning, and thinking. The checklist consisted of 23 items, as listed in Table 4.21. In determining scores for a class, weights were assigned to student responses as follows:

Never	0
A few times	1
1 or 2 times a week	2
3 or 4 times a week	3
Almost every class	4
Every class	5

A mean was then determined for each teacher's class.

Using Criterion 1 for determining the groups for comparison, it will be noted from Table 4.21 that there are few items that differentiate the most effective teachers from the less effective ones. These few differences are in favor of the less effective teachers. The students of the less effective teachers were more likely than those of the more effective teachers to report a high degree of discovery of error in the solutions of classmates, discussion of the work of the class outside the classroom, and the suggestion of new or improved ways of working as a class.

Table 4.20

Comparison of Checklist Responses of Pupils of Most and Least Effective 1960-61 Teachers, According to Criterion 1

Pupil Activity	Most Effective No.	Most Effective Mean	Most Effective S. Dev.	Least Effective No.	Least Effective Mean	Least Effective S. Dev.	t-ratio	Level Sig.
Studied assigned material	19	3.27	0.47	19	3.45	0.47	-0.95	≅.35
Read or studied unassigned material	19	1.21	0.30	19	1.25	0.41	-0.33	NS
Discussed work of course outside class	19	2.05	0.30	19	2.25	0.38	-1.82	≅.07
Asked questions out of curiosity	19	1.62	0.27	19	-1.69	0.39	-0.64	NS
Asked questions because of learning difficulty	19	1.85	0.24	19	2.01	0.40	-1.46	≅.15
Took notes on lectures, solutions of problems	19	1.87	0.40	19	1.63	0.54	1.60	≅.15
Kept trying to understand new material	19	3.43	0.45	19	3.29	0.47	0.93	≅.35
Became frustrated; gave up trying	19	1.27	0.40	19	1.27	0.29	0.00	NS
Solved problems previously worked in class	19	2.07	0.37	19	1.97	0.31	0.91	≅.35
Used newly acquired concepts and vocabulary	19	2.74	0.43	19	2.55	0.50	1.27	≅.20
Applied principles correctly	19	2.89	0.53	19	2.90	0.50	-0.06	NS
Solved new problems similar to previous ones	19	2.94	0.51	19	2.83	0.61	0.61	NS
Helped classmates solve problem, etc.	19	1.85	0.39	19	1.90	0.34	-0.42	NS
Organized ideas into new combinations	19	1.96	0.46	19	2.03	0.47	-0.47	NS
Found errors or defects in classmate's solutions	19	1.38	0.30	19	1.75	0.44	-3.08	<.01
Found errors or defects in teacher's solutions	19	1.05	0.36	19	1.23	0.51	-1.29	≅.20
Discovered relationships of two or more ideas	19	1.91	0.47	19	1.97	0.38	-0.50	NS
Worked out diversity of possible solutions	19	1.43	0.45	19	1.48	0.53	-0.31	NS
Gave up old approach and produced new one	19	1.47	0.44	19	1.55	0.31	-0.47	NS
Thought of unusual, correct solution	19	1.21	0.27	19	1.18	0.21	0.38	NS
Worked out details of some project	19	1.28	0.38	19	1.25	0.45	0.23	NS
Used a principle or concept in new way	19	1.40	0.29	19	1.49	0.40	-0.82	≅.40
Suggested new or improved way of class working	19	0.60	0.23	19	0.85	0.46	-2.08	<.05

A similar but less marked trend in the same direction was noted for studying assigned and unassigned material, asking questions because of learning difficulty, discovery of errors in teacher and textbook solutions, and use of principles or concepts in new ways. An opposite trend was noted for taking notes on lectures, continued efforts to learn, solving problems previously worked in class, using newly acquired concepts and vocabulary, and solving new problems similar to previously solved ones. There is a slight hint in these results that the pupils of the less effective teachers, like their teachers, are less conforming and rules or structure-oriented. They tend to express more awareness of difficulties, problems, difficiencies, and the like. There are also indications that they are more alert to ways by which the functioning of the class could be improved.

At the bottom of the one-page checklist, students were invited to write on the back of the page a description of the learning difficulty that had bothered them most in the SMSG class and how they coped with this difficulty. Many of the responses were quite voluminous and powerfully stated. This was especially true of the pupils of some of the less effective teachers. From these remarks, one gains a picture of these teachers that is in many respects different from the one obtained from the material supplied by the teachers themselves.

Of special interest are the responses of the pupils of those teachers in the low effectiveness groups who did not submit log checklists and solutions to the productive thinking problems. Thus, these teachers could not be considered in the analyses based on these instruments and the picture given by their students gives us about the only data we have concerning their thinking characteristics. An attempt will be made to develop this picture at least in part by presenting a sampling of the comments made in response to the invitation to describe a learning difficulty.

> Student 1. ...It was also because I was afraid to ask questions for fear of being teased or made a fool out of by certain members of the class...
>
> Student 2. I think our teacher is a little impatient with us sometimes and many times he embarrassed us unnecessarily...
>
> Student 3. My difficulty is that the teacher seems to pick on me more than most people. This isn't so bad except that he tries to make you feel like a hopeless case as far as mathematics is concerned. In this way you lose interest in the course...You also begin to dread going to this teacher with the problems you have trouble with because he makes a

funny joke out of your coming or else you hate him so much that you regret going to him or won't admit that you don't understand when he asks you to hold up your hand...But when this is done to a person it has one great asset -- it helps you learn how to control your temper.

Student 4. I think my hardest learning difficulty is my own failure to ask questions about things I don't understand. I don't know why I don't ask questions. Maybe one reason is that I am afraid that the question I ask doesn't make sense or something and I don't know. What I have done to cope with this is just to work an extra little bit harder.

The four students quoted above were in the same class. Their comments present a picture of a rather impatient and intolerant teacher who is rather insensitive to the feelings and difficulties of his pupils. They perceive him as rather unapproachable and their fear and hostility doubtless interfered with their learning.

The comments that follow were submitted by the students of another teacher in the ineffective group. In this case, the students as a group showed a loss rather than a gain from the pre-test to the post-test. The teacher did not submit enough logs to be considered in the other analyses of this study.

Student 5. He is a fair teacher but he will not give a "hoot" if we don't get the material. His ideas are so crazy that it takes a genius to understand him. The tests he gives are so hard that everyone flunks the things. Then when we ask him to explain he won't. Instead he says it is self-explanatory... Please teach the teachers to have correct posture because he always has his dirty feet on the desk. No discipline at ALL. He uses so much grease that if he falls he'll die of injuries.

Student 6. My biggest mistake was taking this course in the first place. First of all, it would help a lot if we had a teacher that could get the idea of the course across to us. It would also help if the teacher would slow down so the kids who at least try to get it but can't have a fighting chance...

Student 7. The most difficult thing about this course is the teacher...Our teacher doesn't help with our problems; he just gives us the answers and tells us to find out how to get them....

The following comments were also made by the students of a third teacher who failed to submit logs and productive thinking problems and could not be considered in the analyses based on them:

Student 8. The big thing I found wrong with this class was that we went so slow that I lost interest and when we went to something else it was the same thing again.

Student 9. The teacher that we have isn't right for teaching this class because he can't explain himself....

Student 10. The teacher is hard to understand. This is not his fault; he tries to explain it, but he thinks on such a different line, none of us can catch on. He is too smart to be teaching high school students. He should be teaching college students.

Student 11. The teacher is hard to understand. When a direct question is asked, we are presented with new and more complicated methods of working problems which does not make understanding easier....

Student 12. We asked our teacher about our questions and other problems, but instead of answering our questions he would go off and explain something else that probably most of us got and then we were really confused, so we never did get our questions answered. To help ourselves we started (some of us) to do it together but then he got mad and said we copied each other's paper, so we haven't done anything since.

Student 13. If we ask you a question, each time you explain it you explain it a little different. This makes me all the more confused. I have tried hard to understand it the first time it is explained and then not listen quite as hard the next few times it is explained again.

The following remarks were submitted by the pupils of a fourth teacher in the least effective group who did not submit logs:

Student 14. I gave up trying to learn geometry at the beginning of the year...I always liked math except for this year maybe because I gave up too easy and it got too hard....

Student 15. I also am lazy and despise the teacher and the way he teaches; therefore, I don't work as hard as I should.

From a student of another member of the least effective group we have the following comment:

Student 16. What bothers me most is the monotony of the class. Our teacher starts talking as soon as the bell rings and continues talking the entire hour, never giving us a chance to work things out in class. He expects us to learn just by showing us how it is done without helping us.

The following comments describe the difficulties of another of the low effective teachers who failed to submit logs and productive thinking problems:

> Student 17. I start drifting away and daydreaming in class and find it hard to concentrate....

> Student 18. I am having trouble concentrating on the class matter because of the excessive noise. At the present time we're about to shoot the course.

> Student 19. I had a hard time generally through the whole year. I wasn't able to grasp the ideas and facts well enough to thoroughly understand what I was doing...I coped with my problem by quitting trying to understand the course...I won't need such extensive math in the career I have chosen.

> Student 20. There is usually so much noise in the class you can't concentrate on what's going on. The kids do a lot of talking and several in the class distract learning.

In their logs the teachers themselves almost never mentioned problems of discipline and did not attribute the learning problem of their students to classroom discipline. Yet from the descriptions of students it seems rather clear that classroom discipline played a rather powerful role in the relatively low effectiveness of some of the teachers in the present study. One may also wonder how the results of the study would have differed from the ones reported had the teachers described by their pupils in the foregoing remarks submitted logs and productive thinking problems. There are reasons to believe that more of the initial hypotheses might have been supported or supported more strongly.

Minnesota Pupil Attitude Inventory

The means of the criterion groups on the fall and spring testings on the Minnesota Pupil Attitude Inventory are compared in Table 4.21. It will be noted that the differences are not statistically significant. There is a general trend for the fall scores to be higher than the spring scores. Flanders indicates that this is a general tendency in a number of studies and seeks to explain it in terms of the initial high hope and the initial delusions students have concerning their teachers and their relationships with them.

Table 4.21

Comparison of Mean Scores on Minnesota Pupil Attitude Inventory of Most and Least Effective 1960-61 Teachers for Each of Two Criteria

Time	Criterion	Most Effective No.	Most Effective Mean	Most Effective S. Dev.	Least Effective No.	Least Effective Mean	Least Effective S. Dev.	t-ratio	Level Sig.
Fall	1	24	221.3	21.5	21	224.7	15.8	-0.55	NS
Spring	1	24	214.4	18.2	22	222.8	25.0	-1.31	<.20
Fall	2	32	226.5	20.2	32	219.3	19.7	1.44	<.20
Spring	2	32	218.5	17.4	32	214.6	22.9	0.76	NS

Classroom Behavior*

During the school year 1960-1961 the classes of ten of the teachers who participated in the SMSG evaluation study of the Minnesota National Laboratory were visited by observers. These observers, using a method developed by Flanders and under his direction, obtained measures of teacher-pupil interaction. This section of the report is a description of the relationship observed between these measures and the achievement test data obtained for the students of these classes as part of the SMSG evaluation study.

A brief description of the interaction measures follows. A full description can be found in "Teacher Influence, Studies in Interaction Analysis", (Final Report of Cooperative Research Project No. 397) by Ned A. Flanders (1960). Also described there are the methods of training observers and of insuring the reliability of their observations.

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*This section of the report was prepared by Ned A. Flanders, director of the subproject on teacher characteristics as assessed by classroom observation.

The observers recorded the type of statements made by the teacher or by the students during the class period. One of the classifications which can be made of these types of statements is that of "direct" statements and "indirect" statements. Direct statements of a teacher are those by which the teacher accepts and encourages student ideas and feelings, or asks questions. Indirect statements are those with which a teacher presents his own or an authority's ideas, gives directions or commands, or criticizes. Flanders has made frequent use of the ratio, I/D, of the number, I, of a teacher's statements classified as "indirect," to the number, D, of those classified as "direct." This ratio was computed for each of the ten teachers.

The same achievement test data described in Chapter 3 were used in this aspect of the study but a slightly different method of determining indexes of effectiveness was employed.

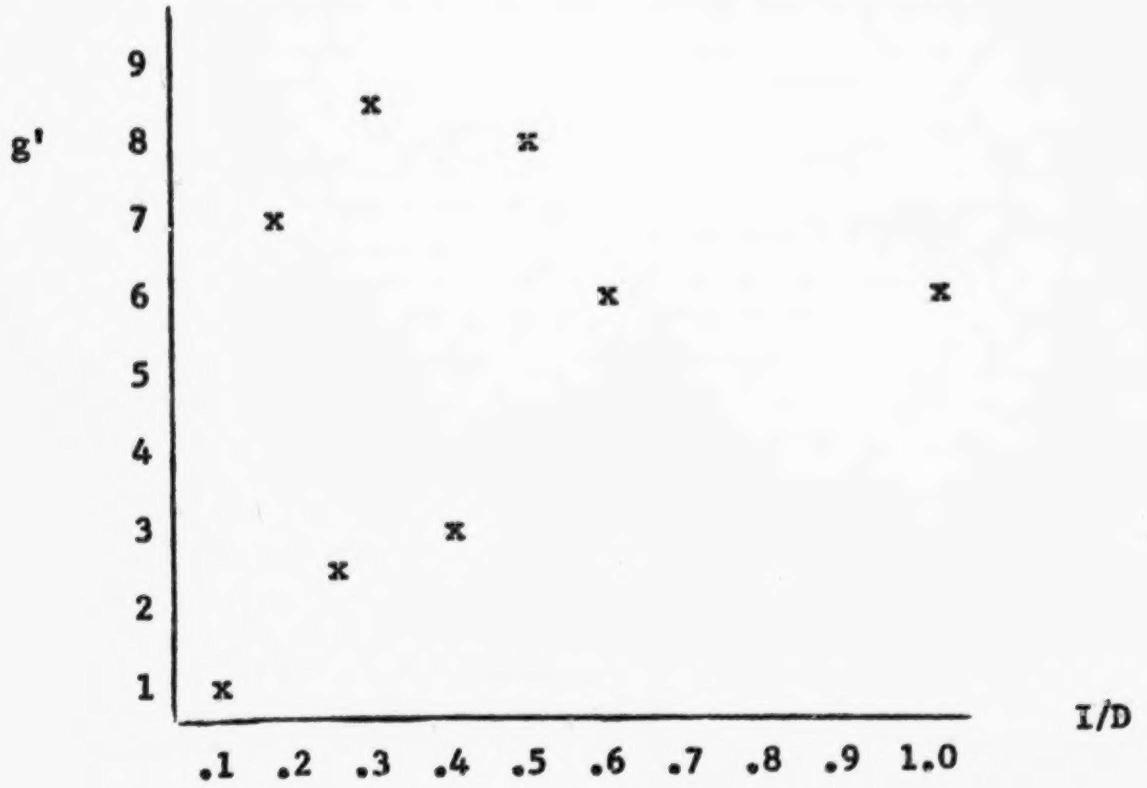
From the student's test scores the average difference, g, between the post-test and the pre-test was calculated for each class. However, the ten teachers here were distributed among all of the grades. There are at least two reasons that g (gain) is not comparable for classes of teachers at different grades. The text, SMSG, is different for the different grade levels. Further, STEP has a tendency to under measure gains for students with high pre-test scores. For these reasons the gains of the classes in each grade were ranked with the gains of all classes at the same grade of the SMSG evaluation study. The rank of the gains of the classes of teachers here was divided by the number of classes in the same grade with which they were ranked. The number so obtained is called g', the relative rank of a class's gain and is the percentile of a teacher's class gain within the distribution of gains for all classes using SMSG at the same grade in the 1960-61 evaluation study.

The values of the variables for the ten teachers are as follows:

Teacher	Grade	g'	I/D
A	7	.94	.50
B	8	.62	.97
C	9	.82	.47
D	10	.11	.10
E	10	.63	.61
F	10	.74	.34
G	10	.68	.18
H	10	.84	.28
I	11	.31	.39
J	12	.27	.26

Thus the average difference between the STEP post-test and pre-test scores for the students of Teacher A was at the 94th percentile of the distribution of these gains for all seventh grade classes of the evaluation study. Also, the observer who classified the statements of Teacher A during six different class periods noted one-half as many "indirect" statements as "direct" statements. (During these six visits the observer classified 3029 statements of the teacher and 2478 statements of students. Of the teacher's statements 1013 were designated as indirect and 2016 as direct.)

The measures of gain, g', and I/D are plotted below.



Clearly, for these teachers, there is a positive relation between the two variables. At the same time the variability of g' for a fixed value of I/D is considerable. The Spearman rank correlation coefficient for these observations has a value of .32 and is not significant at the .05 level. (The .05 critical value for one-sided tests is .564 for $n = 10$.)

Several other variables from the test scores and from the interaction analysis were studied as alternate ways to estimate the association between these two kinds of measures.

As an alternate measure of the teachers' influence on students' achievement the slope, a, of the linear regression equation of the post-test scores on the pre-test scores was calculated for each class. In general, if a slope, a, is larger than one, the students with higher pre-test scores have gains that are greater than those of students with lower pre-test scores. If a = 1, gains are about uniform for all students, and, if a is smaller than one, the students with low pre-test scores have the larger gains.

Thus, the value of the slope, a, for a class gives an indication of which students are making the greater gains. The value of the rank correlation coefficient between the slope, a, and I/D is also .33 for these classes.

Flanders defines another measure, i/d, which is the ratio of the number of indirect statements to the number of direct statements, of a teacher, which are also classified as generally content-free with respect to the particular subject being taught. The rank correlation between the g' and i/d is -.08, and that between the slope, a, and i/d is -.01. These coefficients are so small that the negative sign merits little credence. That they are small in absolute value is most likely attributable to the relatively small number of content-free statements made by a teacher in a mathematics class and the corresponding high variance of i/d.

The rank correlation between the actual observed gain for each class and the value of I/D is .50. This is not reported as the best estimate of the association between the achievement measures and the interaction measures for the following reason. The achievement test has a ceiling and students who score high on the pre-test generally have smaller gains than those who score low. There is evidence that this effect is accentuated as grade increases, probably because of the (self) selection of students who continue to take mathematics courses. Accordingly, a negative correlation between gain and grade level is to be expected. There is, for these teachers, a negative correlation between grade level and I/D. Therefore, there is reason to suspect that the higher correlation between gain and I/D than between relative rank gain and I/D is partially spurious.

All of the data referred to here are included in Table 4.22.

Table 4.22

Summary of Achievement and Interaction Measures for the Ten Teachers Observed in Their Classrooms

Teacher	Grade	Relative rank gain	Observed Gain*	Relative rank slope	Observed slope	I/D	i/d
A	7	.94	9.0	1.00	.964	.50	..84
B	8	.62	4.9	.59	.794	.97	1.55
C	9	.82	7.7	.54	.570	.47	1.19
D	10	.11	.2	.32	.511	.10	.75
E	10	.63	4.0	.50	.551	.61	..52
F	10	.74	4.2	.54	.557	.34	2.41
G	10	.68	4.1	.73	.654	.18	.35
H	10	.84	5.3	.27	.451	.28	1.05
I	11	.31	1.2	.71	.754	.39	1.36
J	12	.27	3.7	.27	.268	.26	1.19

*For the STEP forms group the average difference between fall testing of any two successive grades is approximately 5.

Summary of 1960-61 Study

The application of two different sets of criteria did not yield any real differences in results. Thus, the results of the 1960-61 study can be summarized without reference to the two sets of criteria used in assessing teacher effectiveness.

1. Although there was a great deal of variance in the scores on the measure of productive thinking, the differences between the criterion groups are quite large and statistically significant at a high level. The mean scores of the more effective groups are approximately twice as great as those of the less effective group.

2. Differences between the most and least effective teachers in this study on experience, courses, grades, and professional activity are small and inconsistent. The mean number of years of

mathematics teaching experience of the more effective teachers is greater than that of their less effective peers. The reverse is true, however, of the index based on mathematics courses and grades. When a median test is applied both of these differences fade out.

3. The average amount of time spent in preparation for teaching is almost identical for the criterion groups. The criterion groups also express about the same level of need for additional training in mathematics.

4. From the data presented in this chapter there are only weak indications that procedures in making assignments, explaining new material, conducting learning and thinking experiences relevant to previously assigned material, and evaluating and responding to student performance make a difference in teacher effectiveness. There are consistent, pervasive, and frequently significant indications that the more effective teachers give their students more structure and guidance than do their less effective colleagues. They still give them a great deal of freedom to discover, apply, and search for new combinations.

5. There are also only weak indications of differences in the reports of the most and least effective teachers in their observed evidences of interest, motivation, curiosity, learning, and thinking.

6. Pupil perceptions of their learning and thinking activities show somewhat more difference than do the reported perceptions of their teachers. We find in these differences reflections of the greater degree of structure given by the more effective teachers. There are weak evidences that the pupils of the less effective teachers compared with those of their more effective colleagues ask more questions; more frequently discover errors in the solutions of classmates, teachers, textbooks, and other authorities; more frequently suggest ways of improving the effectiveness of the functioning of the class; more frequently discover new relationships; more frequently find a diversity of solutions; more frequently give up old approaches and discover new ones; and more frequently discuss class work outside the classroom. At first glance one might interpret these differences as indicators of a greater degree of creative or divergent thinking on the part of the pupils of the less effective teachers. One might explain this phenomenon on the rationale that this type of learning is not rewarded by the rather traditional type of achievement test used in this study. One will also note that the pupils of the less effective teachers tended to report a higher frequency of reading and studying both assigned and unassigned material relevant to their mathematics courses.

By synthesizing these findings one would guess that since the less effective teachers do not give their students enough structure, they are forced as a result to rely more upon both their reading as well as upon the more divergent kinds of behavior listed above.

7. The students of some of the least effective teachers who also failed to submit logs and productive thinking problems give a very grim picture of their teachers. This dramatizes one of the limitations of the present study and makes one wonder if the results might have been clearer and more significant if responses could have been obtained from all teachers.

8. The criterion groups did not differ on the responses of students to the Minnesota Pupil Attitude Inventory and the differences in the observed classroom behaviors of the criterion groups were weak and not significant statistically.

Chapter 5

RESULTS OF 1961-62 STUDY

Selection of Criterion Groups

For most of the teacher characteristics explored in the 1961-62 study, analyses were conducted for the same two sets of criteria used in the 1960-61 study. Since the results are essentially the same for the two sets of criteria, no attempt will be made in this chapter to present results separately for them. The results presented herein, with one exception, will be based on comparisons of the criterion groups formed by selecting the upper and lower thirds at each grade level on the g and max. indexes for 1961-62. At the end of the 1961-62 term complete criterion data were available for 63 subjects. Of those ranking in the upper and lower thirds of the criterion, there were relatively complete sets of logs available for 16 of the most effective and 17 of the least effective teachers. Although complete data were available on some teachers for one year and not for another, there was some but not a high degree of consistency between those in the "Most Effective" and "Least Effective" criterion groups for the two years. In fact, a few teachers in the "Most Effective" group in 1960-61 were in the "Most Effective" group in 1961-62 and vice versa.

Experience, Courses and Grades, and Professional Participation

It will be recalled that prior to the initial selection of teachers to field test the SMSG materials, teachers wishing to participate submitted applications. These applications contained information concerning mathematics teaching experience, undergraduate mathematics courses and grades, graduate mathematics courses and grades, and participation in professional mathematics organizations. Official transcripts of courses and grades were also obtained. The means and standard deviations on each of these qualification indexes are presented in Table 5.1 along with t-ratios of the differences in means. Again, it appears from the data presented here that mathematics teaching experience, undergraduate and graduate courses and grades, participation in professional mathematics organizations, and professional contributions do not differentiate the most and least effective teachers in this situation. The results on the first four variables are all in favor of the most effective criterion group and some of them are quite sizeable. The variation within groups is so great, however, that none of them approach statistical significance at the .05 level of confidence.

Table 5.1

Comparison of Means on Experience, Courses and Grades, and Professional Participation of Most and Least Effective 1961-62 Teachers

Variable	Most Effective No.	Most Effective Mean	Most Effective S. Dev.	Least Effective No.	Least Effective Mean	Least Effective S. Dev.	t-ratio	Level Sig.
Experience	15	53.9	6.5	17	49.3	5.9	0.53	NS
Undergraduate Courses and Grades	15	93.6	8.4	17	92.3	8.3	0.12	NS
Graduate Courses and Grades	15	54.7	12.3	17	34.6	9.4	1.30	≅.20
Participation in Professional Mathematics Organizations	15	51.3	11.6	17	31.3	6.8	1.49	≅.15
Professional Contributions	15	10.9	3.9	17	24.5	21.2	-0.63	NS
Total Qualifications Index	15	265.3	21.3	17	229.9	33.7	0.89	NS

The application of the median test is applied to the data on the first four variables in Table 5.2. The results here are even less impressive than those obtained by comparing the means. Thus, this study can be added to a long list of others that fail to show length of teaching experience, courses and grades, and professional participation as a successful predictor of teacher effectiveness.

Productive Thinking in Monthly Reports

Instead of completing the daily log checklists and a different productive thinking problem each month, the 1961-62 teachers were asked to make monthly reports based on the productive thinking problems relative to their most and least successful lessons of the month and to list alternative ways of teaching some mathematics concept studied that month. These reports called for the subject to give indicators by which the lesson selected as most successful could be considered successful

Table 5.2

Comparison by Median Test of Experience, Courses and Grades, and Professional Participation of Most and Least Effective 1961-62 Teachers

Experience

	Most Effective	Least Effective	Total
Above Median	7	9	16
Below Median	8	8	16
Total	15	17	32

Median = 49.8

$X^2 = 0.00$; not significant

Undergraduate Courses and Grades

	Most Effective	Least Effective	Total
Above Median	8	8	16
Below Median	7	9	16
Total	15	17	32

Median = 87.5

$X^2 = 0.00$; not significant

Graduate Courses and Grades

	Most Effective	Least Effective	Total
Above Median	9	7	16
Below Median	6	10	16
Total	15	17	32

Median = 31.8

$X^2 = 0.5019$; not significant

Participation in Organizations

	Most Effective	Least Effective	Total
Above Median	9	6	15
Below Median	6	11	17
Total	15	17	32

Median = 32

$X^2 = 1.0870$

and then to advance hypotheses concerning the factors responsible for this success. Similarly for the least successful lesson, he was asked to list indicators for judging the lesson unsuccessful and to formulate hypotheses concerning the causes of the lack of success. The third report called for the subject to list alternative ways known to him for teaching one of the concepts studied that month and then to produce as many other alternative ways as he could.

In analyzing the data, the first major problem was to identify the ideas that were repeated in the reports, in some cases in all nine of them. It was then possible to determine the total number of indicators produced by each subject and the number of different ones produced. The hypothesized causes were broken down further according to the locus of the blame: teacher, student, material, or the situation. The following are examples of responses falling into each of these four categories:

Causes of Success

Teacher:

My own feeling of ease with the topic.

I gave them practice exercises to determine whether relations are functions.

I gave a good introduction starting out with...

I used a cosine model to show...

I used tables in a step-by-step procedure...

My clumsy explanation. I used breakfast food (Cheerios) and wires. Cheerios are points and wires are lines and we constructed a plane.

Student:

They are all college competent.

Students' knowledge of exponents makes conversion to the use of base 2 somewhat easier.

They were pleased with the accuracy of their results and this motivated them.

Material:

This is a wonderful unit to teach!

Mechanical problems never present much difficulty.

The material presents a large number of examples.

The logical sequence and the discovery aspect of the exercises.

The presentation in the text was very good.

Situation:

They were rested after Easter vacation.

The class is held in the morning.

These students have had SMSG before and this makes it easier.

Causes of Lack of Success

Teacher:

My own feelings of inadequacy with the topic.

My preparation had not been adequate.

The teacher attempted to condense materials too rapidly and thereby caused confusion.

The lack of success was all my fault; we should have...

My lack of sufficient examples from their lives to demonstrate the natural logic and beauty of Geometry.

Student:

Students were not interested and did not listen.

Students had not read their assignments.

Students could not assimilate the materials at this rapid rate.

Students do not clearly understand assigned problems unless an example is given for every problem.

Material:

Material in the text is too concentrated.

Some theory of equations is lacking.

Too many unexplained "why's" in the text and students are not satisfied with the text discussion.

The concept of -- is like dropping a bomb -- too sudden with no lead-on into the new concept.

Situation:

Due to shortness of time (end of school year)...

They were fatigued and had just come from a pep rally.

The period was cut short because of a pep rally.

Since this senior class has had no SMSG experience prior to this year...

The means and standard deviations of the total number of indicators and hypothesized causes and the means and standard deviations of the number of different indicators and hypothesized causes of success and failure are presented in Table 5.3. It will be noted that there is little difference between the criterion groups on the total number of indicators and hypothesized causes of either the successes or failures of lessons. The least effective teachers, however, did produce a significantly larger number of indicators of success than their most effective colleagues. The amount of repetition or duplication is quite high in the reports of the less effective teachers. This trend is consistent in all four cases and is statistically significant in all cases at the .01 level or better, as indicated by larger numbers of different indicators and causes.

Table 5.4 presents a breakdown of the source or locus of the causes advanced by the members of the two criterion groups for the relative success of the lesson cited each month. These differences are quite striking and are in all instances statistically significant. The more effective teachers made the teacher and the students the locus of the causes they hypothesized, while their less effective peers gave the credit to the materials or the situation. In other words, it seems that the more effective teachers see teacher intervention and pupil response as prime factors in successful teaching and learning. The less effective teachers, on the other hand, seem to place their dependence upon the materials. The situation is mentioned rarely by either group.

Table 5.3

Mean Number and Variety of Indicators and Hypothesized Causes of Success or Failure Produced by 1961-62 Teachers and Tests of Significance of Difference

	Most Effective			Least Effective				Level
Variable	No.	Mean	S. Dev.	No.	Mean	S. Dev.	t-ratio	Sig.
Number of Indicators of Success	16	22.9	6.69	17	24.8	8.08	6.31	<.001
Number of Different Indicators of Success	16	10.8	5.87	17	6.6	2.95	5.80	<.001
Number of Hypothesized Causes of Success	16	19.7	9.78	17	19.9	7.02	0.60	NS
Number of Different Hypothesized Causes of Success	16	10.4	6.80	17	7.3	5.60	3.63	<.01
Number of Indicators of "Failure"	16	18.8	5.97	17	19.2	8.21	0.46	NS
Number of Different Indicators of "Failure"	16	8.9	4.03	17	5.6	3.82	15.36	<.001
Number of Causes of "Failure"	16	18.0	8.95	17	16.1	6.73	1.87	<.10
Number of Different Causes of "Failure"	16	8.6	5.62	17	4.5	1.66	20.00	<.001

Table 5.4

Comparison of Basic Sources of Hypothesized Causes of Success of Most and Least Effective 1961-62 Teachers

Source or Locus	Most Effective		Least Effective		Significance of
of Cause	Number	Percent	Number	Percent	Difference
Teacher	130	42	102	30	<.01
Students	96	30	74	22	<.01
Materials	79	25	138	41	<.01
Situation	10	3	24	7	<.05
Total	315	100	338	100	----

Overall Chi Square = 38,868; *df* = 4; significant at <.001

Table 5.5 presents comparable data for the hypothesized causes for the relative lack of success of the lessons cited in their monthly reports. Again, it will be seen that the more effective teachers see teacher intervention as an important factor in unsuccessful teaching-learning experiences. Proportionately, the more effective teachers cite teacher responsibility three times as frequently as do their less effective colleagues. This difference is statistically significant at better than the .01 level of confidence. One of the most interesting facets of these data is that while the more effective teachers credit students with the success of their most successful lessons more frequently than their less effective peers, they less frequently blame students for the lack of success of their least successful lessons. The two groups of teachers cite the materials as being faulty with about equal frequency. The less effective teachers, however, blame the situation about three times as frequently as do their more effective peers.

Table 5.5

Comparison of Basic Sources of Hypothesized Causes of Relative Failure of Most and Least Effective 1961-62 Teachers

Source or Locus of Cause	Most Effective		Least Effective		Significance of Difference
	Number	Percent	Number	Percent	
Teacher	102	36	37	12	<.01
Students	65	23	83	31	<.01
Materials	103	36	102	38	NS
Situation	17	5	52	19	<.01
Total	287	100	274	100	----

Overall Chi Square = 203.636; *df* = 4; significant at <.001 level

It is believed that the variety of different indicators and hypothesized causes produced by the subjects in these monthly reports provides a good measure of their flexibility in teaching. It was hypothesized that the more effective teachers would have available a wider repertoire of skills and techniques and that this would be represented in the flexibility of their thinking as measured by the number of different indicators and hypothesized causes produced. The results of this analysis is presented in Table 5.6. It will be noted that in all four instances that a higher proportion of the ideas of the more effective teachers were different than was found for the less effective ones. In general, about one-half of the ideas produced by the more effective teachers were new, while between two-thirds and three-fourths of those produced by their less effective peers were repetitions of ideas already presented by them.

Table 5.6

Comparison of Percentages of Different Indicators and Hypothesized Causes of Successful and Unsuccessful Lessons of Most and Least Effective 1961-62 Teachers

	Most Effective			Least Effective			Level
Variable	Total	Different	Percent	Total	Different	Percent	Sig.
Indicators of Success	367	174	47	422	112	27	<.01
Causes of Success	315	166	53	338	123	37	<.01
Indicators of Failure	301	143	48	327	95	29	<.01
Causes of Failure	287	138	48	274	76	28	<.01

A somewhat similar concept is involved in the analysis of the data derived from the alternative teaching methods produced for teaching a particular concept each month. The data resulting from this analysis are presented in Table 5.7. Again, there is a strong tendency for the more effective teachers to produce a greater number of different ideas than their less effective ones. The difference is statistically significant at better than the .001 level.

Table 5.7

Comparison of Number of Different Methods Proposed for Teaching Mathematical Concepts Produced by Most and Least Effective 1961-62 Teachers

	Most Effective			Least Effective				Level
Variable	Number	Mean	St. Dev.	Number	Mean	St. Dev.	t-ratio	Sig.
Different Methods of Teaching Concept	16	8.94	8.31	17	4.46	4.84	8.79	<.001

Student Perceptions of Teachers, School, Class, and Materials

It will be recalled that in the spring of 1962, both an SMSG class and a non-SMSG class of each teacher was asked to complete a 64-item questionnaire concerning their attitudes towards or perceptions of their teachers and their methods of teaching, their school, their classmates and their class as a group, and of the instructional materials. Analyses were made both for separate items and for items clustered according to the four categories (teacher, school, materials, and class).

The straightforward analysis comparing the responses of the pupils in the SMSG classes of the most and least effective teachers is presented in Table 5.8. In interpreting the data presented in this table, it should be pointed out that items were scored in such a way that the higher the score the more favorable is the response, regardless of whether the item is worded negatively or positively.

Table 5.8

Comparison of Responses of Students of Most and Least Effective 1961-62 Teachers on Items of Attitude Inventory

Item	Most Effect.		Least Effect.			Level
	Mean	S.Dev.	Mean	S.Dev.	t-ratio	Sig.
1. This teacher helps us enjoy mathematics, even if we are not very good at mathematics.	3.96	0.93	3.38	1.08	6.397	$<.001$
2. My teacher has encouraged this class to think of original solutions to mathematical problems.	4.03	0.88	3.65	1.00	4.469	$<.001$
3. In this class we do not pay attention.	3.81	1.08	3.52	1.14	2.830	$<.01$
4. This teacher encourages us to make guesses at answers before we work them out.	2.45	1.26	2.23	1.12	1.939	$<.06$
5. This teacher tries to find out anything which keeps us from understanding our work.	4.10	1.08	4.06	1.03	0.410	NS
6. My teacher has encouraged this class to discover relationships between two of more ideas, concepts, or system of symbols.	4.29	0.75	3.90	0.89	5.285	$<.001$
7. This teacher praises the class for good work.	3.87	0.80	3.14	1.03	8.806	$<.001$
8. This teacher enjoys discussing mathematics with us in class.	4.51	0.61	4.18	0.81	5.151	$<.001$
9. This school has sensible rules which are easy for most students to obey.	3.93	1.14	3.45	1.35	4.290	$<.001$

Table 5.8 continued

	Most Effect.		Least Effect.			Level
Item	Mean	S.Dev.	Mean	S.Dev.	t-ratio	Sig.
10. The textbook we use has problems which help us to try different but correct solutions to problems.	4.03	0.80	3.67	0.94	4.603	<.001
11. In this class the students are not very interested in having everyone understand the material.	3.66	1.09	3.36	1.06	3.072	<.01
12. My teacher has encouraged this class to think for itself at all times.	3.77	1.05	3.59	1.02	1.873	<.10
13. In this class we have one of the most uncooperative classes I can think of.	4.30	0.98	4.05	1.04	2.800	<.01
14. The textbook we use has helped us to get a good understanding of mathematics.	3.70	0.98	3.15	1.24	5.150	<.001
15. In this class we like mathematics.	3.88	0.84	3.30	1.06	6.721	<.001
16. This school has a great deal of resource materials for extra study.	3.66	1.07	3.52	1.09	1.385	NS
17. This school is not very well cared for and I consider it an unattractive place for the majority of its students.	4.61	0.79	4.22	1.10	4.525	<.001
18. This textbook could not be blamed if we sometimes do not understand mathematics.	3.17	1.22	2.97	1.25	1.845	<.10
19. My teacher has encouraged this class to think of unusual but correct solutions to various problems.	3.29	1.09	3.24	1.01	0.610	NS
20. This teacher has encouraged us to think of reasons for our errors.	4.14	0.82	3.88	0.78	3.509	<.001
21. This school has a staff which is interested in the school's welfare.	4.09	0.81	3.92	1.00	2.069	<.05
22. This school would not be my choice if I could choose my school freely.	3.94	1.25	3.80	1.33	1.213	NS

Table 5.8 continued

Item	Most Effect.		Least Effect.			Level
	Mean	S.Dev.	Mean	S.Dev.	t-ratio	Sig.
23. The textbook we use contains problems which encourage us to think for ourselves.	4.09	0.84	3.84	0.94	3.156	<.001
24. In this class we like to talk about math even when we are not in class.	3.09	1.12	2.49	1.20	5.775	<.001
25. My teacher has encouraged this class to ask questions just out of curiosity.	4.01	0.91	3.68	1.13	3.616	<.001
26. In this class we have one of the most conscientious and hard working classes in the school.	3.26	1.08	2.38	0.87	9.746	<.001
27. My teacher has encouraged this class to make up problems of our own.	2.93	1.10	2.64	0.95	3.053	<.001
28. In this class we come up with good ideas for solving problems.	3.88	0.81	3.43	1.01	5.454	<.001
29. The textbook we use even helps us to "work ahead" of the teacher when we want to.	2.98	1.20	2.59	1.18	3.625	<.001
30. This teacher makes the lessons interesting for this class.	3.80	1.05	3.12	1.20	6.668	<.001
31. My teacher does not encourage this class to ask questions concerning our learning difficulties.	4.38	0.85	4.22	0.87	2.093	<.05
32. This teacher wants us all to do as well as we can on our examinations.	4.73	0.46	4.51	0.69	4.291	<.001
33. This teacher has encouraged this class to think of unusual uses for mathematics in real life.	3.42	1.04	3.12	1.03	3.234	<.01
34. This teacher encourages us to attempt to solve problems even if we make mistakes.	4.30	0.68	4.07	0.74	3.514	<.001
35. My teacher has encouraged this class to work out all kinds of possible solutions, applications, and principles in mathematics.	3.92	0.85	3.59	0.94	4.004	<.001

Table 5.8 continued

Item	Most Effect.		Least Effect.			Level
	Mean	S.Dev.	Mean	S.Dev.	t-ratio	Sig.
36. In this class I like solving problems with my classmates.	4.05	0.82	3.62	1.14	4.851	<.001
37. This teacher is very friendly towards this class.	4.40	0.70	3.79	1.07	7.695	<.001
38. This teacher tries to make sure that we all understand our work.	4.37	0.85	4.22	0.82	1.958	<.05
39. The textbook we use contains exercises which are not very interesting to work out.	3.28	1.24	2.67	1.23	5.476	<.001
40. This school is helping the majority of students become good citizens.	4.25	0.68	4.06	0.87	2.729	<.01
41. This school is organized to help students in as many ways as possible.	4.18	0.83	4.03	1.04	1.875	<.10
42. This school offers extra learning facilities which include a library, audiovisual aids, etc.	4.48	0.59	4.28	0.78	3.276	<.01
43. My teacher has encouraged this class to discuss our work with other people outside of class.	3.16	1.03	3.03	1.06	1.313	NS
44. This school does not help students to develop their interests and abilities.	4.36	0.77	4.19	0.93	2.279	<.05
45. My teacher has encouraged this class to find errors or defects in solutions proposed by teacher, textbook or classmate.	3.84	1.02	3.68	0.99	1.741	<.10
46. The textbook we use could be much improved upon.	2.73	1.20	2.47	1.13	2.522	<.05
47. The textbook we use helps us to understand points we did not quite understand during class.	2.87	1.19	2.39	1.11	4.559	<.001
48. My teacher does not encourage this class to think of original mathematical problems for ourselves.	3.47	1.10	3.21	0.99	2.759	<.01

Table 5.8 continued

Item	Most Effect.		Least Effect.			Level
	Mean	S.Dev.	Mean	S.Dev.	t-ratio	Sig.
49. My teacher has encouraged this class to read or study unassigned material	3.60	1.21	3.59	1.14	0.081	NS
50. This school offers its students a wide range of interesting activities in which they can participate.	4.30	0.82	4.07	1.08	2.680	<.01
51. In this class I get some satisfaction at the end of a math period because we get things done.	3.50	1.14	2.95	1.27	5.040	<.001
52. This teacher loves mathematics.	4.51	0.69	4.24	0.88	3.785	<.001
53. My teacher has encouraged this class to give up old approaches and think of new ones to solve problems.	3.81	0.98	3.75	0.94	0.695	NS
54. This teacher tries to be fair to everyone in the class.	4.37	0.73	3.93	0.96	5.732	<.001
55. This teacher helps us profit from our mistakes.	4.21	0.71	3.88	0.84	4.734	<.001
56. This school will do all it can to help any student in need of help.	4.14	0.82	3.91	1.06	2.646	<.01
57. This textbook is hard to understand.	2.99	1.28	2.40	1.23	5.203	<.001
58. In this class, I am helped to understand new mathematical ideas because of everyone's efforts to work well.	3.64	0.93	3.13	0.98	6.010	<.001
59. This textbook has diagrams and illustrations which help us to understand the material.	3.80	1.01	3.39	1.13	4.197	<.001
60. My teacher has encouraged this class to work out and have our own answers to problems.	3.94	0.78	3.71	0.87	3.068	<.001
61. This teacher encourages us to spot our own mistakes.	4.20	0.65	3.87	0.79	5.119	<.001
62. This school does not make me feel proud to be one of its students.	4.41	0.84	4.27	0.96	1.809	<.10

Table 5.8 continued

Item	Most Effect. Mean	Most Effect. S.Dev.	Least Effect. Mean	Least Effect. S.Dev.	t-ratio	Level Sig.
63. The textbook we use has not helped us to like mathematics.	3.52	1.16	2.92	1.22	5.588	<.001
64. The textbook we use is full of interesting and important things to do.	3.25	1.22	2.71	1.18	4.894	<.001

First, the number of items that yielded differentiations, all in favor of the more effective teachers, is quite impressive. Forty-seven of the 64 items (about three-fourths) yielded differentiations at better than the .01 level of confidence. Only seven of the items (not quite 11 percent) failed to yield differentiations at the .10 level of confidence or better.

The data become more illuminating when we bring in the responses of the pupils in the non-SMSG classes or classes using the traditional materials for their grade levels. This gives us a 2 by 2 layout experimental design, involving two criterion groups of teachers (Most Effective and Least Effective) and two sets of instructional materials (SMSG and Conventional). The design with the number of students in each cell is indicated below:

	SMSG Materials	Conventional Materials
Upper Third Teachers	276	188
Lower Third Teachers	221	212

Three hypotheses for each of the four categories of items seemed to be of interest here. They are:

1. Is there a significant difference between the attitudes or perceptions of the students taught by the teachers with the two levels of effectiveness?
2. Does the treatment applied (instructional materials used) have anything substantial to do with the students' attitudes or perceptions?
3. Is there an interaction between the kind of text materials used and the effectiveness of the teachers, insofar as can be inferred from students' response to the Attitude Inventory?

In the remainder of this section, the three null hypotheses related to the above will be examined for each of the four areas of attitude or perception. Individual items will be considered first and then the groups or categories of items will be analyzed and discussed. The data resulting from the tests on individual items are presented in Table A.1.

Items Related to the Teacher and His Methods of Teaching

It is of interest to note that except on one of the thirty items in the Teacher and Teaching Method category, at least one significant difference was found, and that, no matter whether SMSG or conventional materials were used, the more effective teachers were differentiated from the least effective ones on twenty-six of the thirty items. These differences are quite varied in nature. The effective teachers were characterized as encouraging their students:

to think of original solutions to mathematical problems (Item 2),
to make guesses at answers before they worked them out (Item 4),
to discover relationships between two or more ideas, concepts, or systems of symbols (Item 6),
to think of reasons for errors (Item 20),
to make up problems of their own (Item 27),
to ask questions concerning their learning difficulties (Item 31),
to think of unusual uses for mathematics in real life (Item 33),
to attempt to solve problems even if they make mistakes (Item 34),
to discuss their work with other people outside of class (Item 43),
to ask questions just out of curiosity (Item 25),
to give up old approaches and think of new ones to solve problems (Item 53),
to work out all kinds of possible solutions, applications, and principles in mathematics (Item 35),
to find errors or defects in solutions proposed by the teacher, textbook, or classmate (Item 45),
to think of original mathematical problems (Item 48),
to work out and have their own answers to problems (Item 60), and
to spot their own mistakes (Item 61).

The more effective teachers differed from the less effective ones in praising the class for good work done (Item 7), in enjoying the discussion of mathematics with students in the class (Item 8), in wanting all their students to do as well as they could on their examinations (Item 32), and in trying to make sure that all the students understand their work (Item 38). They are perceived as trying to be fair to everyone in the class (Item 54), helping students to profit from their mistakes (Item 55), as being friendly towards the class (Item 37), and as making the lessons very interesting (Item 30). They were also seen as helping students enjoy mathematics regardless of how good the students are at mathematics (Item 1). And, lastly, they were perceived as loving mathematics (Item 52).

However, the most and least effective teachers were not perceived as being different in encouraging the class to read or study unassigned material (Item 49), to think of unusual but correct solutions to various problems (Item 19), and to think for themselves at all times (Item 12). They did not differ in perceptions of the teacher as trying to find out things that may keep students from understanding their work (Item 5).

In testing the hypothesis related to the two types of texts (SMSG and conventional), it was found that there are statistically significant differences on one-third of the items. The SMSG students more frequently than students using the conventional materials thought that their teachers encouraged them to read and study unassigned material (Item 49), to think of unusual but correct solutions to various problems (Item 19), to discuss their work with other people outside the class (Item 43), to ask questions out of curiosity (Item 25), and to give up old approaches and to think of new ones to solve problems (Item 53).

Similarly, the SMSG students differed significantly from their counterparts using conventional materials in thinking that their teachers tried to find out anything that might keep them from understanding their work (Item 5) and that their teachers love mathematics (Item 52).

There were also a few unexpected findings related to perceptions of teacher behavior and the use of the two types of texts. Students taught by the conventional texts rated their teachers more highly than their SMSG counterparts on being friendly towards the class (Item 37), making the lessons more interesting (Item 30), and helping students enjoy mathematics, even if the latter were not very good at it (Item 1).

Thus, on ten of the thirty items in this category, the type of text materials was associated with differences in the attitudes of students in some way. As described above, in discussing hypothesis one, on seven of these ten items significant differences occurred between the attitudes or perceptions of students taught by the most and least effective teachers. These items are: 1, 25, 30, 37, 43, 52, and 53.

On two items, highly significant interactions were found between the effectiveness of the teachers and the type of text materials used. These items are 52 and 53. Item 52 deals with the teacher's love for mathematics. It appears that the least effective teachers exhibited their love for mathematics more clearly when they used the conventional texts than when they taught the SMSG material. The reverse was the case with the most effective teachers who were perceived by their students as loving mathematics more clearly when they used the SMSG texts than when they used the conventional texts. This suggests that the least effective teachers may not have been flexible enough to adapt their teaching to the new materials.

Similarly, on Item 53, "My teacher has encouraged this class to give up old approaches and think of new ones to solve problems", the least favorable attitude was found among the students taught by the least effective teachers through conventional texts. It is understandable that the least effective teachers would fail, comparatively speaking, to encourage students to give up old approaches and think of new ones, especially when they are using the conventional texts that do not emphasize this type of approach.

Lastly, we come to the only item in this group of thirty on which no significant difference was found on any of the three hypotheses examined here. This Item 12, "My teacher has encouraged this class to think for itself at all times." It may have been that the phrase "at all times" was ambiguous and seemed to claim too much credit for the teacher.

Items Related to the School

There are twelve items in the Inventory related to the school. Their main function was to show whether the attitudes of students taught through the two kinds of text materials and by teachers at the two levels of effectiveness would become generalized to the school as a whole. The implications of such generalized attitudes can be far-reaching, if they can be demonstrated. The picture emerging from the data is heartening. There were five items out of twelve on which none of the three null hypotheses were rejected. Let us look at these hypotheses in the light of the data one by one.

The attitudes of the students of the most effective teachers differed significantly from those of the least effective ones on five items. The students of the most effective teachers expressed more favorable attitudes than those of the least effective teachers on school rules (Item 9). They also thought more favorably of the attempts of the school to help the majority of its students to become good citizens (Item 40), to develop the interests and abilities of students (Item 44), and to offer students a wide range of interesting activities (Item 50). The students of the most effective teachers also differed in thinking more favorably of the degree to which the school is well cared for and its attractiveness to students.

Irrespective of the effectiveness of the teachers, students expressed equal degrees of pride in their school (Item 62) and thought equally well of the learning facilities offered by the school (Item 42). Along with the teachers' effectiveness, we can also consider the use of the SMSG materials on the remaining five items, on which none of the hypotheses was rejected. The results show that irrespective of the kind of text material used and the level of teacher effectiveness, students did not differ in their attitudes or perceptions concerning the resource materials in the schools for extra study and research (Item 16), nor did they do so about the interest of the staff in the students' welfare (Item 21), about the school's being organized to help students in as many ways as possible (Item 41), and about the tendency of the school to do its best to help any student in need of assistance (Item 56). A closer look shows that the immediately preceding three items are quite close in their attitude content and it is quite natural to expect similar results on them. It is also gratifying to note that significant differences were not found in regard to the students' choice of schools, if allowed to choose freely (Item 22).

The hypothesis about the differences between the attitudes of the students taught through SMSG materials and conventional materials was rejected on two of the twelve items. Students taught through SMSG materials differed from their counterparts in their estimate of how well the school is cared for and how attractive a place it is (Item 17), and in their expression of pride in the school (Item 62).

There was a significant interaction between the kind of text materials used and teacher effectiveness on two items. On Item 62 (This school does not make me feel proud to be one of its students), students taught by the most effective teachers using SMSG materials or by the least effective ones using conventional texts expressed more favorable attitudes than the other groups. One possible inference from this is that the least effective teachers could perhaps handle the conventional material more skillfully than they could handle the SMSG materials, and vice versa. However, why there should be a significant interaction on Item 42 (This school offers extra learning facilities) is not easy to understand. It may have been that the least effective teachers are better oriented to and exploit more thoroughly the extra learning facilities of the school, while the most effective teachers focus their attention on materials geared to the SMSG texts.

Items Related to Materials

There were twelve items in the Inventory that were related to the materials used by the teachers. For these items, the reasonable expectation is to find differences for both teacher effectiveness and type of material. It is interesting to note that significant differences were actually found on eleven items on the hypothesis concerning differences in teacher effectiveness and on ten concerning differences associated with the two types of text material.

From the results it would appear that the most effective teachers were significantly different from the least effective ones in teaching with the two different types of texts in such a way that the students of the most effective teachers felt more encouraged than did their counterparts to think for themselves (Item 23), to "work ahead" of the teacher when they wanted to (Item 29), and to try different but correct solutions to problems (Item 10), and to attain a good understanding of mathematics (Item 14). Also, the first category of students differed significantly from the second in thinking that the two types of texts were full of interesting and important things to do (Item 64), helped them to understand points they did not quite understand during the class session (Item 47), and had diagrams and illustrations that helped them to understand the material (Item 59).

Again, the students of the most effective teachers were less inclined to think that the two types of texts contained exercises that were not very interesting to work out (Item 39), that the texts could be greatly improved (Item 46), that the materials were hard to understand (Item 57), and that the text did not help them like mathematics (Item 63).

Let us consider now the differences associated with the two different kinds of texts. Of the twelve items, there are significant differences for ten. Students thought equally well about finding encouragement to think independently from the problems in the two types of text (Item 23), and also about the help they could get from the text in "working ahead" of the teacher if they wanted to (Item 29). Otherwise, the students taught with the SMSG texts expressed significantly more favorable attitudes than did those not so taught on only one item, in thinking that the text helped them to try different but correct solutions to problems (Item 10). Of the remaining nine items, the reverse was the case.

Students taught by the conventional texts showed significantly more favorable attitudes than their counterparts concerning their texts in the following respects:

Helped them get a good understanding of mathematics (Item 14).
Contained very interesting exercises (Item 39).
Did not need much improvement (Item 46).
Was easy to understand (Item 57).
Helped them to like mathematics (Item 63).
Was full of interesting and helpful things to do (Item 64).
Helped them to understand points they did not quite understand during the class session (Item 47).
Had diagrams and illustrations that helped them understand the mathematics (Item 59).
Students should not be blamed if they sometimes did not understand mathematics (Item 18).

The general impression that one obtains from these findings is that the SMSG texts have failed to create a more favorable impression on students than the conventional texts and need further improvement.

On the third hypothesis concerning the interaction between the two kinds of texts and level of teacher effectiveness, significant interaction occurred on two of the twelve items. On them, the least favorable attitude was found among students taught by the least effective teachers through SMSG texts. One of these items (No. 47, The textbook we use helps us to understand points we did not quite understand during class.) is general in nature. Responses to this item showed that students taught by the least effective teachers and with the SMSG materials felt more strongly than other students that the text did not help them understand unclear points. On the other item (No. 59), the same students rated comparatively low the help they received from diagrams and illustrations. It should be noted, however, that the early edition of the SMSG texts contained few diagrams and illustrations.

Items Related to Generalization of Attitudes to the Class

On the first hypothesis concerning differences in attitudes or perceptions of the class as a group, it is interesting to note that on all ten items in this area the students of the most effective teachers showed significantly more favorable attitudes than did those taught by the least effective ones. Specifically, the former group was differentiated from the latter in feeling that their class paid attention (Item 3), took interest in having everyone understand the material (Item 11), was the most cooperative (Item 13), liked mathematics (Item 15), and talked about the subject even outside class (Item 24). The students expressed a liking for solving problems with their classmates (Item 36) and were thus helped in understanding new ideas (Item 56), derived a sense of satisfaction and accomplishment at the end of a mathematics period (Item 51), and came up with good ideas for solving problems (Item 28). The former category of student also felt that the class was very conscientious and hard-working (Item 26).

On the second hypothesis, however, quite a different picture emerged. Only on two of the ten items relevant to students' attitudes concerning their classes are there statistically significant differences. While students using the SMSG materials thought that their classes were exceptionally conscientious and hard-working (Item 26), those using the conventional materials derived a greater sense of satisfaction and accomplishment at the end of the class (Item 51). Apparently it seems that progress through the SMSG texts is comparatively slower and less satisfying in the judgment of students.

Coming to the third hypothesis, we find again that only on two of the ten items is there significant interaction. Consistent with the general pattern witnessed thus far, the students of the least effective teachers taught through the SMSG texts showed the least favorable attitude in regard to coming up with good ideas for solving problems (Item 28) and on their estimates of the conscientiousness and hard-workingness of their classes (Item 26).

Items Considered in Four Categories as Groups

Thus far, the results presented from the attitude inventory have been based upon individual items in each of the four categories. To analyze the overall results of all of the items in a single category, two-way analyses of variance were performed, using the means on each of the items of a particular category, forgetting the within-cell variance for each of the four cells. For the four categories of items, the results are presented in Table 5.9.

Table 5.9

Means and F-Ratios for All Items of the Student Attitude Inventory in Each of Four Major Categories for Most and Least Effective 1961-62 Teachers

	Means			F-ratios		
Category	Most Effective	Least Effective	Degrees of Freedom	Teacher Effectiveness	Kind of Text	Interaction
Teachers	3.94	3.67	1,116	9.12*	0.07	0.00
School	4.19	3.98	1,44	4.39*	0.59	1.37
Materials	3.40	3.03	1,44	7.24*	3.81	0.03
Class	3.72	3.27	1,36	8.28*	0.48	0.22

* Indicates statistical significance at the .05 level or better

The really important observation that one can make concerning these results is the clear and consistent indication that the effectiveness of the teacher has a great deal to do with the attitudes and perceptions of students. This brings into bold relief the importance of improving the effectiveness of the least effective teachers. This does not, however, imply that nothing can or should be done by the most effective teachers to improve their effectiveness. Improvement of their effectiveness also deserves attention and the results of this study supply numerous clues concerning the ways by which this might be done.

Summary

In many respects, the results of the 1961-62 study are more clear-cut and compelling than those obtained in the 1960-61 study and in some respects reinforce and extend these earlier findings reported in Chapter 4.

1. The results reported in this chapter strengthen the conclusion that the effectiveness of teachers using the SMSG materials as measured by student learning is not influenced to any significant degree by the length of the teacher's experience in teaching mathematics, his undergraduate and graduate courses and grades, and his participation in professional mathematics organizations. Apparently, if a teacher meets minimum qualifications in these respects, higher qualifications in these areas do not make a difference.

2. The results obtained in the 1960-61 study concerning the superiority of the productive thinking ability of the most effective teachers can now be accepted with greater confidence. This same superiority was also demonstrated by the most effective teachers in the present study. The most effective teachers produced a greater variety of ideas about indications of success and failure in their teaching, hypothesized causes of success and failure, and produced a greater variety of alternative ways of teaching mathematical concepts.

3. When teachers in the 1960-61 study used a checklist to indicate their activities and those of their pupils, the results did not differentiate very effectively and consistently between the most and least effective teachers. In this study, however, where reliance was placed upon the teacher to report in his own words these activities, differences appear as they did in the 1958-59 and 1959-60 studies. The nature of the hypothesized causes of the most and least effective teachers are strikingly different. In making hypotheses concerning the cause of the success of the most successful lesson each month, the most effective teachers emphasized teacher and student behavior while the least effective ones gave the credit to the instructional material. In hypothesizing about the causes behind the relative failure of their least effective lesson each month, the most effective teachers again emphasized teacher behavior, while their least effective colleagues emphasized pupil behavior and the situation.

4. Finally, the results of this study indicate quite strongly that the effectiveness of the teacher has a great deal to do with the attitudes and perceptions of pupils concerning teachers and their methods, the school, the text materials, and the class as a group.

Chapter 6

DISCUSSION

The Criterion Problem

This study, as almost every investigation of teacher effectiveness ever conducted, has been harassed from beginning to end by the criterion problem. From the very beginning of the study, it had been decided that teacher effectiveness would be determined on the basis of pupil learning during the school year. It was also agreed that corrections would be made for initial status of knowledge and aptitude. It was necessary, however, to measure mathematics learning through the use of tests ill-suited to the purpose. The tests used had two major deficiencies insofar as the goals of the study are concerned: (1) the ceilings on some of the tests were too low and (2) some of the more important objectives of the SMSG materials were not assessed by these tests. In the light of these limitations, however, the authors feel that they have done about as well as they could. Actually, a great deal of time and energy was invested in analyzing the data according to the ideas of various persons concerning the most important criteria. With the basic data derived from the testing program, however, the use of different criteria seemed to make practically no differences in the results of the study, as the reader has doubtless observed in the report of the results for the 1960-61 study where two different sets of criteria were employed.

Conventional Qualifications

Some readers will be disappointed that the conventional teacher qualifications of length of teaching experience, undergraduate courses and grades, graduate courses and grades, and participation in professional activities in one's field of specialization again failed to differentiate between the most and least effective teachers. Actually, there is a certain degree of comfort in these findings. First, they give added confidence to similar findings in other studies of teacher effectiveness. Second, those who produced the SMSG textbooks will be reassured to know that the experimental instructional materials are equally well suited to a wide range of teachers in terms of these conventional qualifications. Common sense, of course, tells us that these qualifications do make a difference. Certainly no one should conclude from this study that we can expect effective mathematics teaching from teachers who have no experience in teaching mathematics, no undergraduate or graduate courses in mathematics (or failing grades in such courses), and lack of interest in the mathematics teaching profession. In the present study, teachers lacking in mathematics teaching experience usually had had considerable course work and reasonably good grades while those lacking strong course work and/or grades had had considerable experience. Nevertheless, the results do tell us that in order to find superior teaching in mathematics we need to look for other characteristics outside the limits of these conventional qualifications.

Time Spent in Preparation

Some readers will likewise be disappointed that the time spent in preparation for a class did not differentiate the subjects according to effectiveness. Again, common sense tells us that we cannot expect high levels of effectiveness from teachers who do not prepare themselves. All of the teachers participating in this study made perhaps minimally adequate preparation. It is also likely that the amount of time consciously spent in preparing for a lesson is not an adequate measure of actual preparation. It is quite likely that the real "payoff" in terms of teacher effectiveness results from the creative, productive energy set in motion by the awareness of problems arising in a class session and of those arising in the conscious preparation. There is probably payoff in the incubation process or preconscious thinking that occurs while eating, taking a bath, shaving, or the like. Using these cues, it may be possible to conduct studies that will result in more penetrating and definitive knowledge concerning teacher effectiveness and methods of increasing this effectiveness.

Classroom Observations and Checklists

Some readers will also be disappointed that measures obtained from classroom observations and detailed checklists of teacher and pupil activities were no more successful than they were as predictors of teaching effectiveness. It is true that the measures derived from classroom observations showed some promise and that the number of teachers observed was small and the number of observations limited. The fact remains, however, that the results in this study are no more positive than those of earlier studies in this area of investigation and development. It may be that other kinds of observations would be more successful. In fact, the results derived from the productive thinking measures suggests that this may indeed be true. There does seem to be some kind of fundamental difference in the classroom behavior of the most and least effective teachers. The problem is to find ways of objectively measuring these differences.

The senior author had placed much hope in the detailed checklist of teacher and pupil activities. Analyses of the daily logs of the teachers in the 1958-59 and 1959-60 studies had been used in identifying the kinds of behaviors that seemed to differentiate the most and least effective teachers. It is true that some of these indicators showed promise and that the investigators were handicapped by the fact that some of the least effective teachers did not submit the log checklists and could not be considered in the study. It is also true that the checklists of students and those of some of the teachers were quite discrepant in some respects. Thus, it is possible that some teachers, especially the less effective ones, are not aware of some of the problems that exist and block the learning of their students.

Measures of Productive Thinking

In some respects, it is surprising that the measures of productive thinking were as consistently successful as they were in predicting teacher effectiveness in this study. Some readers will doubtless be skeptical of these results. From the outset, it was intended that the exploration of teacher reports as measures of productive thinking ability be one of the unique contributions of this project. This intention was not altogether motivated by some kind of "blind faith." A number of studies in other areas have shown that data derived from instruments calling for the productive thinking of subjects predict effectiveness when more objective measures fail. The senior author would make no strong claims for the validity, reliability, and objectivity of the productive thinking measures employed in this study. On a logical, rational basis, however, one would expect the way a teacher copes with the problems posed to the subjects would be related to his effectiveness as a teacher. The measures were derived by counting the occurrence of written verbal behaviors that can be identified with a high degree of reliability. It certainly makes good sense that the teacher who is able to marshal the intellectual energy necessary for the productive thinking called for in the reporting forms would be more successful in coping with problems of classroom teaching than those unable to do so. It makes good sense that the effective teacher recognizes at a rather deep level that the behavior of the teacher and of the student play important roles in successful lessons and that the teacher has a responsibility for unsuccessful lessons. It also makes sense that the effective teacher is able to produce a greater variety of ideas rather than repeat unsuccessful ones.

While the senior author sees nothing strange or unbelievable in the results of this study relative to the measures of productive thinking that he and his associates developed, he does recognize the need for replications and continued efforts to improve such measures. The consistency with which these measures differentiated the subjects according to teaching effectiveness, the large differences in means, and the high level of statistical confidence of the differences are certainly encouraging.

Student Attitudes

One of the most interesting and provocative findings of the study is that teacher effectiveness is as strongly related as it is to student attitudes concerning teaching methods, the resources of the school, their classmates, and their textbooks. It is also interesting that instructional materials have significant effects upon some of these attitudes. Of more interest, however, is that fact that teacher effectiveness has a stronger and more pervasive influence on these attitudes than does the instructional materials.

Chapter 7

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Researchers and educators are rarely justified in drawing firm conclusions, implications, and recommendations from any single study. When related to the existing body of knowledge and anchored in it, the authors feel that it is justifiable to draw firm conclusions about some findings, especially those in harmony with existing knowledge, but that it is necessary to be cautious about findings at variance with existing knowledge and about findings resulting from explorations into hitherto unexplored areas. It is this belief that has guided the formulation of the conclusions, implications and recommendations listed in this chapter.

Teaching Experience, Courses and Grades, and Professional Participation

Conclusions

Above some undetermined minimal level of mathematics teaching experience, mathematics courses and grades, and participation in professional organizations, these conventionally accepted qualifications of teachers do not differentiate the most and least effective teachers using the experimental SMSG materials.

Implications

It would appear that the creators of the SMSG instructional materials were successful in their attempt to provide materials usable by teachers with a wide range of teaching abilities. These materials appear to be adapted to the wide range of teacher qualifications found in this study. Administrators may have some degree of confidence in permitting minimally qualified teachers to use these materials. It must be remembered, of course, that the teachers participating in this study apparently wanted to experiment with the SMSG materials. To be selected they had to apply and their schools also had to be willing that they experiment with these materials.

Recommendations

Researchers should look beyond the conventionally accepted qualifications of length of teaching experience, mathematics courses and grades, and professional participation in their search for the characteristics of outstanding mathematics teachers. It might be well to undertake some definitive studies to determine minimal levels below which superior teaching cannot be expected. It may also be useful to explore the relative potency of specific kinds of mathematics teaching experience, achievement in mathematics courses, and professional participation. For example, it is likely that ten years of teaching the same thing the same way will contribute no more to teaching effectiveness than one year of teaching. There is some indication that this phenomenon may be operating in the present study. It will be recalled that in the 1961-62 study the most and least effective teachers were not differentiated by the number of indicators and causes they produced regarding their most and least successful lessons. The least effective teachers, however, repeated the same indicators and causes. When this repetition was eliminated, there was a highly significant differentiation between the least and most effective teachers.

Principals, personnel officers, and school boards should also recognize the need for looking beyond length of teaching experience, courses, grades, and professional participation both in selecting teachers and in promoting and otherwise rewarding them. The findings call into serious question traditional concepts about length of teaching experience and number of college credits as determiners of salary level.

Length of Time Preparing for Teaching

Conclusions

The length of time consciously spent in preparing to teach a lesson does not differentiate the most effective from the least effective mathematics teachers using the SMSG experimental materials.

Implications

The implications of this conclusion are not direct. Indirectly, however, some unusually intriguing conclusions may be drawn. It is likely that the "big payoff" in teaching effectiveness comes from the preconscious thinking that occurs following a class session and following the deliberate, conscious preparation. The problem is to discover what facilitates the productive, preconscious thinking or creative problem-solving that apparently makes possible this high level of teaching effectiveness. Once the facilitating conditions have been identified, it will then be possible to increase the chances that this kind of thinking will occur. There are now available a number of provocative leads concerning this problem in the accumulating literature concerning creative problem solving. The findings of this study do not suggest that conscious, deliberate preparation is not essential to effective mathematics teaching. It is not likely that the creative problem solving will take place without this kind of preparation.

Recommendations

Researchers and individual teachers should try to obtain a better understanding of the kind of daily preparation that is necessary for effective teaching. Efforts should be made to find ways of studying the creative thinking processes that take place between a class session and deliberate, conscious preparation of the next lesson and between this preparation and the actual teaching of the next lesson. There is sufficient reason from other lines of investigation to expect that disciplined approaches to creative problem solving will increase the chances that more effective teaching will occur.. If this can be demonstrated, teacher education programs and school administrators would have strong justification for developing procedures that will aid teachers in the acquisition of the skills necessary for a more disciplined approach to creative problem solving as a part of habitual professional behavior.

Reports of Teacher and Pupil Activities

Conclusions

When reliance is placed on the use of checklists of teacher and pupil activities or on relatively standardized observations of these activities, there are few differentiations of any consequence. There are rather strong indications, however, from the checklist data that the most effective teachers tend to give their students more structure in the form of assignments in textbooks and supplementary material; the assignment of specific problems, both those requiring applications and a single correct answer; and giving correct solutions to problems. They also seem to give more guidance or structure in the form of evaluations, especially in pointing out defects in solutions, analyzing causes of errors, and identifying alternative approaches rather than through tests, check quizzes, and the discussion of these.

When reliance is placed on an objective analysis and quantification of subjective reports by teachers of their activities and thinking and those of their students, a variety of differentiating characteristics emerge between the least and most successful teachers. The most successful compared with the least successful ones produce a greater number of solutions to problems and demonstrate a higher degree of flexibility in thinking as reflected in the variety of ideas produced. They are more fully aware of the importance of what both the teacher and the student does to make a lesson successful. They are also more willing to accept responsibility for unsuccessful lessons and to be aware of what they do that contributes to lack of success. They are less likely than their less effective peers to place the blame on students for unsuccessful lessons.

Implications

Researchers might be more successful in gaining an understanding of the dynamics of effective teaching and in discovering what differentiates effective from ineffective teaching by placing less reliance on precoded checklists and more reliance on objectifying and quantifying the subjective reports of teachers of their experiences. More reliance might also be placed upon the reports of students concerning how they experience the teaching. It might also be well for both teachers and researchers to examine more fully and penetratingly the ways by which teachers give structure and guidance to classroom learning experiences and the ways by which they judge the amount and kind of guidance that will be most effective.

In the supervision of student teachers and teachers in service, there is a need for supervisors to develop and evaluate alternative ways of creating an awareness of the teacher's role in the success or lack of success of their teaching. They also need to recognize that what students do is important in the success of a lesson, just as it is in the lack of success of a lesson. In other words, supervisors should help teachers become more aware of their own behavior and of the effect of their behavior on that of their students.

Student Attitudes

Conclusions

Both teacher effectiveness and instructional materials have important effects on student attitudes concerning teachers, teaching methods, schools, classmates, and textbooks. Teacher effectiveness, however, is by far a more powerful determiner of these attitudes.

Implications

The implications of this conclusion are far-reaching. One of the more obvious ones is that when teachers encounter negative attitudes concerning teaching methods, the school, classmates, and textbooks, they should take stock of their teaching effectiveness and seek to discover more effective ways of teaching. Dissatisfaction with a teaching method, a textbook, or a classmate may possibly be related to the overall effectiveness of the teaching being encountered by the student. Researchers would do well to consider student attitudes in seeking to understand the dynamics of teaching effectiveness.

Although there would be a need to exercise considerable caution, the manifestation of negative attitudes concerning the school, fellow students, teaching methods, and the like may be looked upon by administrators and curriculum workers as possible indicators of or warnings concerning ineffective teaching.

Chapter 8

SUMMARY

Purpose of Study

The School Mathematics Study Group (SMSG) was anxious to determine whether the experimental mathematical instructional materials they were developing were adapted for use by teachers of widely varying qualifications. In addition, the present investigators were interested in studying in more penetrating ways the characteristics of teachers that affect learning. They were especially anxious to test the usefulness of observations of classroom interaction and reporting forms that might reveal the thinking characteristics of mathematics teachers. Thus, they asked the following two major questions:

1. Is teacher effectiveness related to the pattern of interaction between teacher and student and to the classroom climate created by this interaction?
2. Is teacher effectiveness related to the productive thinking abilities of teachers as reflected in the daily logs submitted by teachers throughout the school term?

Status of Relevant Knowledge

In general, the literature on mathematics teacher characteristics indicates that such gross characteristics as length of mathematics teaching experience, number of undergraduate and graduate credits in mathematics, grades in mathematics courses, and participation in professional activities are not especially promising as differentiators of the most and least effective teachers. In a few studies, there has been a tendency for length of teaching experience and number of undergraduate mathematics courses to show some promise. Most studies, however, suggest that one must look beyond these gross characteristics in order to differentiate superior teachers. Teacher attitudes, the nature of the teacher-student relationship, and similar variables appear to become increasingly important as investigators get away from measures of achievement that require more or less mechanical operations and depend more on tests that call for applications and the solution of new problems.

Among the characteristics found to differentiate teachers according to effectiveness are: favorable attitudes concerning children and young people, realistic concepts concerning human nature and development, differentiated assignments, the use of life applications, the use of review, the offering of free comments concerning performance on examinations, and the like. A number of studies have indicated that there is a relationship between individual achievement and attitudes concerning mathematics, but there has been little or no investigation of the extent to which these attitudes are influenced by teacher effectiveness and the instructional materials used. Some studies also indicate that there is an interaction between teaching style and certain learner characteristics such as dependence proneness and need for structure or guidance. In general, however, studies attempting to relate mathematics teaching effectiveness to personality variables have not been very rewarding.

Procedures

Data for the present investigation were collected during the 1960-61 and 1961-62 school terms. The subjects were 127 teachers who had participated in a statewide field study designed to evaluate the experimental instructional materials developed by the School Mathematics Study Group ranging from grade seven through twelve. These teachers and their schools had made application for participation in the field test. The applicants were stratified according to length of teaching experience, number of undergraduate and graduate mathematics credits, grades in mathematics courses, and participation in professional mathematics activities. The subjects were then selected by random methods within each stratum. At the beginning of the 1960-61 term, 107 of these 127 teachers were still available and agreed to continue participating. By the end of the school term, however, complete predictor and criterion data were available for only 75 of them. By the end of the second year, complete predictor and criterion data were available for only 63 of them.

Both in 1960-61 and 1961-62, each subject taught the experimental SMSG materials to one of their classes. The students in these classes were administered the following testing program:

Fall: School and College Ability Tests, Verbal and Quantitative (grades seven and eight) or Differential Aptitude Tests, Verbal and Quantitative (grades nine through twelve); and Sequential Tests of Educational Progress, Form A, at levels appropriate to the subjects.

Spring: Sequential Tests of Educational Progress in Mathematics, Form B, at appropriate levels.

In the fall of 1960 and the spring of 1961, students were also administered Flanders' Student Attitude Inventory. In the spring of 1961, they were also administered Torrance's Student Checklist of Learning Activities and in the spring of 1962, Dawson's Student Attitude Inventory. In the spring of 1961 the Checklist of Learning Activities and in the spring of 1962 Dawson's Student Attitude Inventory were also administered to the students of the participating teachers in a non-SMSG class. In 1960-61, the participating teachers completed the Teacher and Pupil Activity Checklist for two lessons each week and at the end of each month completed a reporting form designed as a test of the teacher's productive thinking ability. In 1961-62, they completed at the end of each month reports concerning their most and least successful lessons and alternative methods of teaching one of the mathematics concepts taught that month.

Two sets of criteria were used in assigning teachers to criterion groups. The first criterion consisted of a combination of two indexes: g (mean gain in mathematics achievement from pre-test to post-test, accepted as a measure of how well the average student learns) and max.(largest difference between regression line of post-test on aptitude test at points on the mean, one standard deviation below the mean, and one standard deviation above the mean, accepted as a measure of how well the teacher teaches that part of the class that he teaches best). The "most effective" group consisted of those ranking in the upper third at each grade level on these indexes; those ranking in the lower third were placed in the "least effective" group. The second criterion was based on the Z scores developed from the modified median gain in mathematics achievement from pre-test to post-test. The "most effective" group consisted of those who ranked in the upper half at each grade level on this criterion level and the "least effective" group was made up of those ranking in the lower half.

Results of the 1960-61 Study

The application of the two different sets of criteria did not yield any real differences in results. Thus, the results of the 1960-61 study can be summarized without reference to the two sets of criteria used in assessing teacher effectiveness.

1. Although there was a great deal of variance in the scores of the most effective teachers on the measure of productive thinking, the differences between the criterion groups are quite large and statistically significant at a high level. The mean scores of the most effective teachers are approximately twice those of the least effective ones.

2. Differences between the most and least effective teachers in this study on length of mathematics teaching experience, courses, grades, and professional activity are small and inconsistent. The mean number of years of mathematics teaching experience of the most effective teachers is greater than that of their less effective peers. The reverse is true, however, of the index based on mathematics courses and grades. When a median test is applied both of these differences fade out.

3. The mean amount of time spent in preparation for teaching is almost identical for the criterion groups, regardless of how they are determined. The criterion groups also express about the same level of need for additional training in mathematics.

4. From the data presented in this chapter there are only weak indications that procedures in making assignments, explaining new material, conducting learning and thinking experiences relevant to previously assigned material, and evaluating and responding to student performance make a difference in teacher effectiveness. There are consistent, pervasive, and sometimes significant indications that the more effective teachers give their students more structure and guidance than do their less effective colleagues. They still give them a great deal of freedom to discover, apply, and search for new combinations.

5. There are only weak indications of differences in the reports of the most and least effective teachers in their observed evidences of interest, motivation, curiosity, learning, and thinking.

6. Pupil perceptions of their learning and thinking activities show somewhat more difference than do the reported perceptions of their teachers. One finds in these differences reflections of the greater degree of structure and guidance given by the more effective teachers. There are weak evidences that the pupils of the less effective teachers compared with those of the more effective ones ask more questions; more frequently discover errors in the solutions of classmates, teachers, textbooks, and other sources of authority; more frequently suggest ways of improving the effectiveness of the functioning of the class; more frequently discover new relationships; more frequently find a diversity of solutions; more frequently give up old approaches and discover new ones; and more frequently discuss class work outside the classroom. At first glance one might interpret these differences as indicators

of a greater degree of creative or divergent thinking on the part of the pupils of the least effective teachers. One might explain this phenomenon on the rationale that this type of learning is not rewarded by the rather traditional type of achievement test used in this study. One will also note that the pupils of the least effective teachers tended to report a higher frequency of reading both assigned and unassigned material relevant to their mathematics courses. By synthesizing these findings one would guess that since the less effective teachers do not give their students enough structure, they are forced as a result to rely more upon both their reading and the more divergent kinds of behavior listed above.

7. The students of some of the least effective teachers who also failed to submit logs and productive thinking problems give a rather grim picture of their teachers. This highlights one of the limitations of the present study and makes one wonder if the results might have been clearer and more significant if responses could have been obtained from all teachers in the study.

8. The criterion groups did not differ on the responses of students on Flanders' Minnesota Pupil Attitude Inventory and the differences in the observed classroom behaviors of the criterion groups were weak and not significant statistically.

Results of the 1961-62 Study

In many respects the results of the 1961-62 study are more clear-cut and compelling than those obtained in the 1960-61 study and in some respects reinforce and extend these earlier findings.

1. The results of the 1961-62 study strengthen the conclusion that the effectiveness of teachers using the SMSG materials as measured by student learning is not influenced to any significant degree by the length of the teacher's experience in teaching mathematics, his undergraduate and graduate courses and grades, and his participation in professional mathematics organizations. Apparently, if a teacher meets acceptable qualifications in these respects, higher qualifications do not make a difference and it is necessary to look beyond these gross measures to differentiate superior teachers.

2. The results obtained in the 1960-61 study concerning the superiority of the productive thinking ability of the most effective teachers is strongly reinforced by the results of the 1961-62

study and can be accepted with greater confidence. The most effective teachers produced a greater variety of ideas about indications of success and failure in their teaching, hypothesized a greater variety of causes of success and failure, and offered a greater variety of alternative ways of teaching mathematical concepts than did their less effective peers.

3. When teachers in the 1960-61 study used a checklist to indicate their activities and those of their pupils, the results did not differentiate very effectively and consistently between the most and least effective teachers. In this study, however, where reliance was placed upon the teacher to report in his own words these activities, differences appear in a very marked degree as they did in the 1958-59 and 1959-60 studies. The nature of the hypothesized causes of the most and least effective teachers are strikingly different. In making hypotheses concerning the causes of the success of the most successful lesson each month, the most effective teachers emphasized teacher and student behavior while the least effective ones gave the credit to the instructional materials more frequently. In hypothesizing about the causes behind the relative failure of their least effective lessons, the most effective teachers again emphasized teacher behavior, while their least effective colleagues emphasized pupil behavior and the situation.

4. The results of the analysis of the attitude inventory completed by SMSG students and non-SMSG students taught by the same teacher at the same grade level indicate that both teaching effectiveness and instructional materials have a great deal to do with the attitude and perceptions of pupils concerning teachers and their methods, the school, text materials, and the class as a group. By far the most powerful factor seems to be teacher effectiveness.

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Table A.1

Means and Standard Deviations of Attitude Scores of Pupils of Most and Least Effective 1961-62 Teachers Using SMSG Text Materials on Individual Items of the Student Attitude Inventory and F-Ratios to Test Significance of Effects of Teacher Effectiveness, Kind of Text, and Interaction

	Most Effective				Least Effective				F-Ratios		
	SMSG		Convent'nl		SMSG		Convent'nl		Teacher	Kind	
Item*	Mean	S.Dev.	Mean	S.Dev.	Mean	S.Dev.	Mean	S.Dev.	Effect.	of Text	Interaction
1	3.96	0.93	4.22	0.73	3.38	1.08	3.47	1.01	107.19	7.28	1.80
2	4.03	0.88	3.89	1.02	3.65	1.00	3.75	1.04	15.62	0.87	3.18
3	3.81	1.08	3.90	0.98	3.52	1.14	3.66	1.03	13.48	2.61	0.07
4	2.45	1.26	2.57	1.31	2.24	1.11	2.25	1.20	10.11	0.67	0.41
5	4.10	1.08	3.92	1.21	4.06	1.03	3.93	1.13	0.04	4.23	0.10
6	4.29	0.75	4.15	0.82	3.90	0.89	3.93	0.79	31.07	1.02	2.37
7	3.87	0.80	3.69	1.01	3.14	1.03	3.14	1.14	91.36	2.08	1.57
8	4.51	0.61	4.46	0.61	4.18	0.81	4.17	0.77	43.47	0.41	0.09
9	3.93	1.14	3.90	1.18	3.45	1.35	3.67	1.15	19.20	1.23	2.27
10	4.03	0.80	3.88	0.96	3.67	0.94	3.53	1.00	32.23	4.72	0.15
11	3.66	1.09	3.61	1.09	3.36	1.06	3.39	1.06	12.82	0.00	0.29
12	3.77	1.05	3.76	1.13	3.59	1.02	3.66	1.15	3.41	0.14	0.30
13	4.30	0.98	4.23	1.09	4.05	1.04	4.05	1.04	3.97	0.48	3.07
14	3.70	1.15	3.96	1.00	3.15	1.24	3.53	1.09	41.54	17.79	0.66
15	3.88	0.84	3.98	0.87	3.30	1.06	3.23	1.00	108.99	0.06	2.08
16	3.66	1.07	3.55	1.11	3.52	1.09	3.45	1.05	2.49	1.59	0.07
17	4.61	0.79	4.23	1.12	4.22	1.10	3.98	1.29	19.45	18.60	0.83
18	3.17	1.22	3.40	1.17	2.97	1.25	3.39	1.16	1.80	15.69	1.42
19	3.29	1.09	3.07	1.20	3.24	1.01	2.99	1.09	0.86	10.09	0.02
20	4.14	0.82	4.11	0.92	3.88	0.78	3.90	0.92	16.19	0.02	0.15

Table A.1 continued

	Most Effective				Least Effective				F-Ratios		
	SMSG		Convent'nl		SMSG		Convent'nl		Teacher	Kind	
Item*	Mean	S.Dev.	Mean	S.Dev.	Mean	S.Dev.	Mean	S.Dev.	Effect.	of Text	Interaction
21	4.09	0.81	3.97	1.09	3.92	1.00	4.02	0.90	0.93	0.01	2.82
22	3.94	1.25	3.83	1.34	3.80	1.33	3.88	1.28	0.26	0.32	1.22
23	4.09	0.84	4.00	0.91	3.84	0.94	3.81	0.95	13.04	1.04	0.27
24	3.09	1.12	3.19	1.12	2.49	1.20	2.49	1.12	72.38	0.41	0.46
25	4.01	0.91	3.76	1.09	3.68	1.13	3.51	1.05	17.59	9.08	0.28
26	3.26	1.08	2.68	1.14	2.38	0.87	2.67	1.12	38.79	4.30	36.09
27	2.93	1.10	2.90	1.10	2.64	0.95	2.52	1.02	22.65	1.09	0.51
28	3.88	0.81	3.63	0.97	3.43	1.01	3.49	1.01	21.31	2.06	5.69
29	2.98	1.20	3.01	1.28	2.59	1.18	2.62	1.13	23.27	0.17	0.00
30	3.80	1.05	4.06	1.06	3.12	1.20	3.36	1.19	81.76	10.99	0.02
31	4.38	0.85	4.36	0.90	4.22	0.87	4.19	0.98	7.42	0.25	0.02
32	4.73	0.46	4.70	0.51	4.51	0.69	4.52	0.73	24.82	0.03	0.22
33	3.42	1.04	3.49	1.05	3.12	1.03	3.20	1.13	17.17	1.09	0.01
34	4.30	0.68	4.28	0.69	4.07	0.74	4.04	0.82	22.08	0.21	0.02
35	3.92	0.86	3.89	0.89	3.60	0.94	3.67	1.02	18.87	0.11	0.70
36	4.05	0.82	3.96	1.01	3.62	1.14	3.60	1.10	36.56	0.69	0.28
37	4.40	0.70	4.46	0.78	3.79	1.07	3.99	1.07	76.57	4.41	1.30
38	4.37	0.85	4.51	0.74	4.22	0.82	4.26	0.87	12.17	2.55	0.70
39	3.28	1.24	3.32	1.23	2.67	1.23	3.00	1.24	31.46	5.04	2.96
40	4.25	0.68	4.16	0.89	4.06	0.87	4.01	0.90	9.30	1.52	0.12
41	4.18	0.83	4.15	0.84	4.03	1.04	4.09	0.84	3.26	0.05	0.67
42	4.48	0.59	4.30	0.88	4.28	0.78	4.33	0.72	2.90	1.83	5.54
43	3.16	1.03	3.14	1.09	3.03	1.06	2.75	1.00	13.70	4.47	3.77

Table A.1 continued

	Most Effective				Least Effective				F-Ratios		
	SMSG		Convent'nl		SMSG		Convent'nl		Teacher	Kind	
Item*	Mean	S.Dev.	Mean	S.Dev.	Mean	S.Dev.	Mean	S.Dev.	Effect.	of Text	Interaction
44	4.36	0.77	4.21	1.02	4.19	0.93	4.14	0.92	4.04	2.72	0.71
45	3.84	1.02	3.83	1.00	3.68	0.99	3.50	1.14	11.93	1.68	1.42
46	2.73	1.20	2.91	1.20	2.47	1.13	2.73	1.16	7.88	7.82	0.30
47	2.87	1.19	2.97	1.17	2.39	1.12	2.86	1.17	13.95	13.25	5.47
48	3.47	1.10	3.60	1.11	3.21	0.99	3.08	1.20	27.80	0.02	3.04
49	3.60	1.22	3.32	1.17	3.59	1.14	3.26	1.21	0.21	14.50	0.12
50	4.30	0.82	4.20	0.99	4.07	1.08	4.07	1.01	7.54	0.71	0.56
51	3.50	1.14	3.88	0.95	2.95	1.27	3.18	1.18	65.23	15.83	1.04
52	4.51	0.69	4.45	0.68	4.24	0.88	4.51	0.68	4.04	4.62	11.30
53	3.81	0.98	3.74	1.13	3.75	0.94	3.27	1.14	14.19	15.48	8.46
54	4.37	0.73	4.39	0.80	3.93	0.96	4.10	0.91	40.59	2.90	1.48
55	4.21	0.71	4.31	0.77	3.88	0.84	3.96	0.80	41.52	3.17	0.03
56	4.14	0.82	3.93	1.09	3.91	1.06	3.96	0.99	1.98	1.52	3.84
57	2.99	1.28	3.71	1.10	2.40	1.23	3.36	1.09	34.50	110.36	2.26
58	3.64	0.93	3.56	1.03	3.13	0.98	3.25	1.01	39.83	0.08	2.27
59	3.80	1.01	3.99	0.96	3.39	1.13	3.99	0.74	9.56	35.54	9.24
60	3.94	0.78	3.84	0.99	3.71	0.87	3.63	1.10	12.31	2.07	0.14
61	4.20	0.65	4.14	0.93	3.87	0.79	3.88	0.98	27.78	0.22	0.38
62	4.41	0.84	4.08	1.15	4.27	0.96	4.30	1.03	0.29	5.22	7.51
63	3.52	1.16	3.72	1.14	2.92	1.22	3.40	1.18	34.13	18.54	2.95
64	3.25	1.22	3.47	1.19	2.71	1.18	3.04	1.19	35.92	11.61	0.35

*Item number corresponds to the numbering of the items in Table 5.8

MANUAL FOR LOG BOOK FOR SMSG COURSES
Minnesota National Laboratory - Mathematics Section

Prepared by E. Paul Torrance

September 1960

BUREAU OF EDUCATIONAL RESEARCH
College of Education
UNIVERSITY OF MINNESOTA

MANUAL FOR LOG BOOK FOR SMSG COURSES

INTRODUCTION

During 1958-59 and again during 1959-60 mathematics teachers using the SMSG experimental materials under the auspices of the Minnesota National Laboratory for the Improvement of High School Mathematics kept daily logs of their activities and those of their students. This was an extremely significant and imaginative undertaking on the part of the Minnesota group. To evaluate new materials, new methods and procedures, and other innovations in education, it is essential to know what takes place in the classroom and outside the classroom as a consequence of their introduction.

Some preliminary analyses have been made of the 1958-59 and 1959-60 logs and reports are now being prepared for distribution to participants during the fall of 1960. We believe that this material has given us some insights concerning the characteristics of the most and least effective teaching and concerning the effects of the SMSG material on what goes on in the classroom.

The logs submitted, however, have been extremely uneven. Some teachers consistently gave an excellent picture of the activities of both teachers and pupils. Others told almost nothing except that certain pages of the SMSG materials had been assigned or covered. The reporting system for 1960-61 has been designed in an attempt to obtain a maximum of useful data with a minimum of effort on the part of the instructor. We hope that after the first week or two you will be able to complete a log for one day's work in less than ten minutes. An effort has been made to make the items in the check list easily understood and we trust that you have had little difficulty in completing your check lists while you have been waiting for this manual. We trust, however, that this manual with its examples and definitions will help you to be more aware of your own thinking processes and the learning and thinking processes of your pupils.

The Log Books

The reporting system will consist of a set of nine log books, one for each month. Each log book will contain enough of the basic reporting forms or check lists to last for a month. For each lesson reported, there is a check list describing teacher activities and another for pupil activities. In addition, we are asking you to describe any special learning difficulties experienced by your pupils. Once each month we are asking you to prepare a special report, each on a different problem. We believe that each of these will provide very valuable information in assessing and improving the SMSG materials, as well as provide useful insights concerning the general process of motivating and guiding pupils in the learning and thinking processes. These logs will mean little, however, unless you complete them carefully and conscientiously each week.

In the sections which follow a brief explanation will be given of each item in the check list.

Part I. Teacher Activities

Time Estimates

We realize that you will not actually time yourself on everything you do to prepare for your teaching activities. It is particularly difficult to include that time when you are doing other things but thinking about teaching the SMSG materials and we realize that this is some of the most productive time. It is when some of your best ideas about teaching occur. You should, however, be able to give a fairly accurate account of your deliberate, conscious activities, such as reading, working problems, preparing instructional materials, making up tests, evaluating pupil work, and the like. We have provided the following categories for reporting your time estimates:

SMSG Materials: Reading the materials, working problems, preparing teaching aids suggested by the materials, making up tests, etc.
Other Texts, Professional Literature, etc.: Reading other high school textbooks, college mathematics textbooks, books on the teaching-learning-process, articles in professional journals, preparing teaching aids and working problems suggested by such reading, etc.
Original Work: Preparing instructional materials and doing other work to carry out original idea, special project, or the like. Making up original problems, developing new concepts for teaching course, new concepts to be taught, etc.

Need to Learn More Mathematics

Since the SMSG materials include many of the newer concepts in mathematics, from time to time you may feel the need to learn more mathematics. It is important that you report these experiences in connection with each lesson, so that the writers of the materials can provide as much help as possible and so that more adequate in-service training courses can be prepared. Simply check "yes" or "no" to indicate whether or not you felt a need to learn more mathematics yourself in order to teach the lesson under consideration.

The Check-List: General Instructions

The procedure of using the check ( ) and double check ( ) has been devised simply as a rough indicator of the frequency with which the activity occurred. We realize that it would be impractical for you to indicate the actual number of times you performed each activity. We believe, however, that you will have no difficulty recalling at the end of a session whether or not you engaged in the activity and if so whether or not it was continuous or occurred three or more times.

1. Assigned homework, outside class activities, etc.

Check the blank at the left of "1" if you assigned any kind of homework or outside class activity for the next day or any other future time. If you assigned no homework, do not check any of the activities under "1." If you assigned homework, check as many as apply.

1.1 **Assigned problems from text**

Use this category, if you assigned problems or activities given or suggested in the SMSG text.

1.2 **Assigned problems from supplementary sources**

Use this space, if you assigned problems or activities taken from other texts, references, journals, magazines, and the like.

1.3 **Assigned problems you developed**

Use this space, if the problems or activities you assigned have only one correct, best or accepted solution.

1.4 **Assigned problems requiring correct solutions**

Use this space, if the problems or activities you assigned have only one correct, best or accepted solution.

1.5 **Assigned problems requiring divergent solutions**

Use this category, if there is no one correct or acceptable solution to the problem or activity assigned. This is quite likely to be true of many of the outside activities you may assign where there are several possible ways of solving a problem. It may also be true of some of the specific problems which you assigned. Check this category if the assignment permits divergent solutions rather than requires convergent ones (the one correct answer).

1.6 **Assigned problems requiring application of rules and principles**

Check this category, if your assignment requires the simple application of rules and principles. It will include most drill exercises, routine manipulation problems, and the like.

1.7 **Assigned problems requiring discovery of new rules or principles**

Check this category, if you assigned a problem or project to be done over an extended period of time (three or more days). This may include expecially difficult problems, special projects, discovery activities, and the like. Such activities require thinking which is likely to occur only when the pupil has a chance first to identify the problem and study it and then mull over it, letting the process of incubation and insight take place during a period of time.

2. **Explained new material**

Place a check in the blank at the left of the "2" if you spent any time explaining or presenting new material. If you check this category, then check as many of the subcategories as apply. If you do not check this blank, do not check any of the subcategories.

2.1 **Routinely followed text or teacher commentary**

Check this category if your explanation of new material routinely followed the SMSG materials, the text and teacher commentary, or if you followed the explanation given in these materials only with minor modifications.

2.2 **Used special device suggested by SMSG materials**

Check this category if you used a demonstration, visual aid, or any other special instructional device suggested by the SMSG materials.

2.3 Used special device adapted from colleague or other source

Check this category if you used a demonstration, strategy, visual aid, or other special device adapted from a colleague, professional, journal, methods text, or similar source (not SMSG material).

2.4 Used original device or procedure you developed

Check this category if you used a demonstration, strategy, visual aid, gimmick, or other special device you thought of and developed yourself to aid in presenting new concepts, principles, operations, and the like.

2.5 Made quick test (question, problem) to find out if explanation has been comprehended

Do not use this category for questions or problems designed to evaluate pupil performance. In other words, it should be "off the record" insofar as the pupil is concerned and should not count in determining his grade. Its major purpose should be to evaluate the effectiveness of your presentation of the new material.

3. Conducted learning and thinking activities of previously assigned materials

Check this major category if you devoted any time to learning and thinking activities of previously assigned materials (including materials assigned for the specific day under consideration). If no time was devoted to such activities, do not check any of the subcategories. If this broad category was checked, use as many of the subcategories as apply.

3.1 Answered pupil questions

Check this item if you answered questions initiated by pupils concerning the assigned materials.

3.2 Gave correct solution(s) to problem(s)

Check this item if you worked out problems for pupils or otherwise gave correct solutions or answers, rather than stimulating them to find solutions.

3.3 Stimulated pupil(s) to find correct solution(s)

Check this item if you stimulated the class or individuals in the class to find correct solutions rather than giving them the solution yourself. This should include instances when you give minimum clues, call for the pooling of ideas from the class, or otherwise discover solutions where there had been prior failure to find a solution.

3.4 Gave alternative or divergent solution(s) to problem

Check this item if you offered two or more ways of solving a problem or demonstrated that the problem has diverse solutions.

3.5 Stimulated pupil(s) to find alternative or divergent solutions

Check this item if you stimulated pupil(s) to find two or more ways of solving a specific problem, diverse solutions, many possible solutions, and the like.

3.6 Asked pupil(s) to reproduce previously presented ideas, information, or solutions

Check this category for activities requiring recognition, memory, or problem-solving in connection with ideas, information, or solutions already presented to the class. This does not include activities requiring new solutions from previously learned materials.

3.7 Had pupil(s) present solutions to new or assigned problems at blackboard

Check this category if any time was devoted to having pupils present solutions of any type at the blackboard.

3.8 Stimulated competition within class

Check this category if you promoted activities which placed pupils in competition with one another. This might include seeing who can solve problems in shortest length of time, who can solve the most problems in a given length of time, and the like.

3.9 Had pupils work in pairs or other small groups

Check this category if any time was devoted to activities in which pupils worked in pairs or other small groups. This might involve activities in which a superior pupil teaches weaker ones, pupils working mutually trying to solve problems, or any type of cooperative learning and thinking activity.

4. Evaluated pupil achievement

Check this broad category if you devoted class time to the evaluation of pupil achievement. If you do not check this category, do not mark any of the subcategories. If you checked this category, use as many of the subcategories as apply.

4.1 Gave test or check-quiz

Check this category to indicate the administration of any type of test, examination, or check-quiz.

4.2 Discussed or analyzed test results

If any time was devoted to the discussion or analysis of test results after your evaluations have been completed, check this category.

4.3 Pointed out defects in pupil solution(s)

If you spent time correcting or pointing out errors and other defects in pupil solution(s), check this category. Such defects may be pointed out in regard to tests used in evaluating achievement and in the learning and thinking activities in section 3.

4.4 Pointed out other approaches or solutions

Check this category if you devoted time to demonstrating or describing other approaches or solutions not given by pupils, even though those of the pupils may have been "correct." Again, this may be in connection with tests, blackboard work, or other learning and thinking activities.

4.5 Analyzed causes of errors or inability to solve problems

Check this category if you analyzed and pointed out to pupils the causes of their errors or inability to solve problems. By cause, we mean what skill deficiency, lack of information, thinking pattern, or the like resulted in the error or failure. This does not include telling the pupil that his solution is incorrect bacause he did not factor correctly. If you pointed out to him the reason why he did not factor correctly and helped him to analyze the reason for his not factoring correctly, this would apply.

4.6 Praised pupil for correct solution

Check this category if you commended or otherwise praised a pupil for solving correctly a difficult problem or one difficult for him.

4.7 Praised pupil for original solution or unusual idea

Check this category if you praised a pupil for offering an original solution or unusual idea concerning some problem or concept under consideration. Usually, this will occur only in relation to problems which have more than one "correct" solution or which do not have a traditional "best" answer.

5. Used special teaching aid

Check this broad category if you used any kind of special teaching aid other than the blackboard, standard charts, and the like. Check as many of the subcategories as apply.

5.1 Film or other commercially produced audio-visual aid

Check this category if you used a film, film-strip, recording, or the like which has been commercially produced.

5.2 Visual or audio-visual aid you developed

Check this category if you used a teaching aid which you developed yourself, whether you made it yourself or had it made in a shop or elsewhere.

5.3 Special reference, magazine article, pamphlet, etc.

Check this item if you made use of any kind of special reference, magazine article, pamphlet, object, design, painting, or the like.

6. Other activities

Under this broad category, list any activities not covered by the specific check-list items. This might include field trips, guest lectures, unusual demonstrations, and other unusual activities. If needed, use the back of the page for listing and describing these activities. It will be especially helpful if you will use this space for describing unusual projects, activities, or approaches not easily described by traditional dimensions.

Part II. Check-List of Pupil Activities

In describing pupil activities, we would like for you to use a three-point scale instead of a two-point one. Use a single check for each activity you observed at least once for at least one pupil, a double check if you observed it at least once for a majority of your pupils, and a triple check if you noted it more than once or continuously for a majority.

Evidences of Interest, Motivation, Curiosity

1. Evidenced having studied assigned material

Check this item if you observed signs which convinced you that the assigned materials had been studied. Such signs would include: homework ready to hand in, ability to solve problems on blackboard, ability to answer questions, ability to ask questions indicative of having studied, rather than questions indicative of not having studied, and the like.

2. Evidenced having read or studied unassigned material

Check this category if you saw signs which indicated that pupils had read or studied additional unassigned material in connection with the subject under study. This might include spontaneous contributions in class, reports to the class of additional readings, magazines and books brought to class to show you and/or other pupils, conversations among pupils outside class indicative of having read additional materials, and the like.

3. Evidenced having discussed work outside class

Use this category whenever you see indications that pupils have discussed the classwork outside the class among themselves, with parents, or with others in the community. Such evidence may result from casual observations outside the classroom in school and social activities, reports of parents and other teachers, requests to referee arguments arising from such discussions, and the like.

4. Asked question(s) which indicated curiosity

Use this category if a pupil or pupils asked questions indicative of curiosity, rather than questions indicative of inattention or failure to grasp explanation. It might include questions concerning unanswered issues, materials not yet covered, the reasons for principles, the applications or consequences of principles, or new or unusual ideas suggested by the materials and concepts under study.

5. Asked question(s) which indicated learning difficulty

Check this item if pupil(s) asked questions indicating that they were experiencing difficulty in mastering the materials under study. This might include questions asked to clarify explanations, to find out what to do next, to find out what errors had been made, to find out why the solution is incorrect, and the like.

6. Took notes on lectures, solution of problems at blackboard, etc.

Check this item if you noted that a pupil or pupils took notes on lectures, explanations, solutions of problems and the like.

7. Aggressively kept trying to understand, solve problems, etc.

Check this category if you noted that pupil(s) aggressively kept trying to understand a concept or solve problems where they might otherwise have given up and stopped trying. This will usually occur only in connection with the mastery of new and difficult concepts and problems.

8. Became frustrated; gave up trying to understand, solve problems, etc.

Use this category if you noted that pupil(s) became frustrated and stopped trying to understand or solve problems. Again, this will usually occur in connection with new and difficult material but may occur among students of marginal ability and poor motivation even when the material is familiar and relatively simple.

Evidences of Learning

1. Reproduced previously presented ideas and/or solutions

Check this category to indicate observed evidence that pupil(s) remembered previously presented ideas, information, solutions, and the like. We are concerned here primarily about the functioning of the memory abilities.

2. Used newly acquired vocabulary

Check this item as an indicator that pupil(s) used spontaneously newly acquired vocabulary in connection with the course.

3. Recognized correct principle for solving problem

Check this category if pupil(s) recognized the correct principle for solving a problem or correctly applied a principle. This usually involves the manipulation of symbols according to rules, as in solving routine algebra problems.

4. Solved new problems similar to previously explained ones

Check this item if pupil(s) solved new problems similar to previously explained ones. This may involve selecting from several previously learned procedures the one needed to solve the new problem.

5. Helped fellow pupils solve problems, learn principles, etc.

Check this category if you observed a pupil helping another solve a problem, learn a principle, understand a percept, etc. This category may be used to include both spontaneous, pupil-initiated cooperation and teacher-directed cooperative activities. It may also include both mutual assistance and assistance to weak students by the abler ones.

6. Organized information, ideas, symbols into an optimal sequence

Mark this category if you observed pupil(s) organizing information, ideas, symbols, etc. into an optimal, logical sequence. This category would include arranging in the proper sequence appropriate suggested steps for solving a problem, for discovering how to solve a new problem, for testing an hypothesis, etc.

7. Identified errors or defects in solution proposed by classmate(s)

Mark this category if pupil(s) identified and pointed out defects or errors in a solution proposed by classmate(s).

8. Identified errors or defects in solution by teacher, text, etc.

Mark this category if pupil(s) identified and pointed out defects or errors in solution by teacher, text, or other authority.

Evidences of Thinking

1. Discovered relationship between two ideas, concepts, etc.

Check this category if pupil(s) discovered a relationship between two or more ideas, concepts, or rules. Primarily, this will involve seeing the connection between two ideas or concepts, but may also involve the perception of spatial patterns, the relationship between two figures or symbols, and the like.

2. Discovered complex relationship in pattern or system of symbols

Mark this item if pupil(s) discovered a complex relationship in a pattern or system of symbols, such as deciphering a code, figuring out a progression, or the like.

3. Visualized what a pattern or set of relationships would look like if rearranged

Check this item if pupil(s) gave evidence that they visualized what a pattern or set of relationships would look like if rearranged. For example, visualized what a geometric figure would look like if inverted, what a complex geometric figure would look like if disassembled and rearranged, what an instrument panel would look like if the dials were rearranged, what a polynomial would look like if rearranged, etc.

4. Explored visually several solutions, courses of action, etc.

Mark this category if pupil(s) gave evidence of having explored visually several possible solutions or courses of action, preparatory to selecting the most effective. This would involve such things as seeing ahead several steps in the proof of a geometric theory or in the solution of an algebra problem; seeing ahead several moves in chess; etc.

5. Saw beyond the immediate and obvious

Check this category if pupil(s) gave evidence that they saw beyond the immediate and obvious. This involves the ability to penetrate beneath or beyond the explicit assumptions, given principles, etc. It may involve making a considerable leap in thinking from the givens to the solution or going deeper into the givens.

6. Produced a diversity of possible solutions, applications, etc.

Check this category if pupil(s) produced a diversity of possible solutions, applications of principles, etc. This involves keeping out of ruts by jumping readily from one train of thought to another in thinking of new solutions, new application, new approaches, etc.

7. Abandoned conventional approach and thought of original solution

Mark this item if pupil(s) abandoned conventional problem-solving methods that have become unworkable and thought of original solutions. This may occur when the pupil has a set for solving a problem in a particular way, using a particular set of rules, or the like, and must abandon this set and find a solution for himself.

8. Produced clever or uncommon responses

Mark this item if pupil(s) produced clever or uncommon responses in a specific situation. Such thinking will usually occur in response to difficult problems, problems for which no rules have been given, or problems permitting a diversity of possible solutions.

9. Worked out the details to develop a general idea, solve a problem, etc.

Use this category if pupil(s) worked out the details to develop or implement a general idea or plan, solve a problem, or the like. This involves the ability to elaborate, to fill in the gaps, to build onto an idea. It would involve such activities as suggesting the specific steps that should be taken to carry out a change in class procedure, to test a specific hypothesis, etc.

10. Suggested a symbol that will satisfy a general relationship

Check this item if pupil(s) suggested a symbol (word, letter, number, formula, etc.) that will satisfy a given relationship. A simple example would be to state the smallest odd number that is also a perfect square.

11. Used a principle, object, concept in a new way

Mark this item if pupil(s) used a principle, object or concept in a new way. For example, a given rule may have been used in solving a particular type of problem. The pupil is confronted with a new type of problem and he uses the rule to solve the new problem.

12. Suggested improved or new way of working, functioning as a class, etc.

Mark this item if pupil(s) suggested improved or new ways of working or functioning as a class -- ways of maintaining order, using supplementary materials, presenting reports, helping one another, etc.

Other activities not included above

List under this broad category any important pupil activities not included in the categories listed and described above. Distracting activities, morale building activities, and the like might well be included.

Analysis of learning difficulties

Please describe on the back of the pupil-activity list any particular learning difficulties noted among your pupils. These may be relevant to specific pupils, a specific category of pupil, or to all pupils in your class. Indicate the nature of the difficulty and what step(s) you took to cope with the problem. If you have any hypotheses concerning the causes of the difficulty, please include these. THIS IS VERY IMPORTANT

Special Monthly Report

Each month you will be asked to prepare a brief report on some special aspect of your experience in using the SMSG materials. An attempt will be made to state the problems as clearly as possible. Most of them, however, will call for you to use your imagination. We want your ideas, opinions, suggested solutions, evaluations, and inventions.

Month:________________________________

MINNESOTA NATIONAL LABORATORY - MATHEMATICS SECTION

Log Book

Name of Teacher ____Grade __________

City______________________________School ___________________________

Number in Class ___________________

INSTRUCTION: This booklet contains a set of materials to last for one month in reporting your daily activities and those of your pupils in SMSG courses. Each week select two days and use the forms provided to describe what you did, what your pupils did, and the results of these activities. A separate form is provided for each day. Each month, you will be asked to make a special analysis of one lesson out of that month.

This revised reporting system has been devised in an attempt to make your job of reporting easier and the information obtained more useable. It is hoped that you will continue to put into these reports the careful thoughtfulness found in most reports last year. These reports will play an important role in evaluating the experimental materials and in discovering some of the important elements in effective mathematics teaching. Already the materials provided by the daily log submitted during the past two years have led to a number of important insights concerning the effects of the materials and the nature of effective mathematics teaching.

Each month, mail your log book to: Professor E. Paul Torrance, Bureau of Educational Research, University of Minnesota, Minneapolis 14, Minnesota. Include with your log book any supplementary material you have which will help in understanding what happened in your class. Include copies of tests, your analysis of the results, handouts to pupils, photographs and the like.

BUREAU OF EDUCATIONAL RESEARCH
College of Educational
UNIVERSITY OF MINNESOTA
December 1960

MINNESOTA NATIONAL LABORATORY - MATHEMATICS SECTION
DAILY LOG

Teacher:________________________Grade:______________Date:______

Material covered on this date:____________________________________

Part I. Teacher Activities

Approximate time spent in preparation of this lesson: SMSG materials_____
Other texts, professional literature, etc. ________Original work___
Found need to learn more mathematics? Yes_________No____________

CHECK-LIST: Enter in the blanks at the left a single check ( ) for each activity you engaged in at least once during this lesson and a double check ( ) for each activity which occurred continuously or three or more times.

___ 1. Assigned homework, outside class activities, etc.
  ___1.1 Assigned problems from text
  ___1.2 Assigned problems from supplementary sources
  ___1.3 Assigned problems you developed
  ___1.4 Assigned problems requiring a correct solution
  ___1.5 Assigned problems requiring divergent solutions
  ___1.6 Assigned problems requiring application of rules or principles
  ___1.7 Assigned problems requiring discovery of new rules or principles
  ___1.8 Assigned sustained project requiring three or more days

___ 2. Explained new material
  ___2.1 Routinely followed text or teacher commentary
  ___2.2 Used special device suggested by SMSG materials
  ___2.3 Used special device adapted from colleague or other source
  ___2.4 Used original device or procedure you developed
  ___2.5 Made quick test (question, problem) to find out if explanation had been comprehended

___ 3. Conducted learning and thinking activities of previously assigned material
  ___3.1 Answered pupil questions
  ___3.2 Gave correct solution to problem(s)
  ___3.3 Stimulated pupil(s) to find correct solution
  ___3.4 Gave alternative or divergent solution to problem
  ___3.5 Stimulated pupil(s) to find alternative or divergent solutions
  ___3.6 Asked pupil(s) to reproduce previously presented ideas, information, or solutions
  ___3.7 Had pupil(s) present solutions to new or assigned problems at blackboard
  ___3.8 Stimulated competition within class
  ___3.9 Had pupils to work in pairs or other small groups

___ 4. Evaluated pupil achievement
  ___4.1 Gave test or check-quiz
  ___4.2 Discussed or analyzed test results
  ___4.3 Pointed out defects in pupil solution(s)
  ___4.4 Pointed out other approaches or solutions
  ___4.5 Analyzed causes of errors or inability to solve problems
  ___4.6 Praised pupil for correct solution
  ___4.7 Praised pupil for original solution or unusual idea

___ 5. Used special teaching aid
    ___5.1 Film or other commercially produced audio-visual aid
    ___5.2 Visual or audio-visual aid you developed
    ___5.3 Special reference, magazine article, pamphlet, etc.

___ 6. Other activities (specify): (Use back of page.)

Check-List of Pupil Activities

Enter in the blanks at the left a single check ( ) for each activity you observed at least once for one or more pupils, a double check ( ) for activities observed at least once for a majority of your pupils, and a triple check ( ) for activities occurring more than once for a majority of the pupils.

1. Evidences of interest, motivation, curiosity
    ___1.1 Evidenced having studied assigned material
    ___1.2 Evidenced having read or studied unassigned material
    ___1.3 Evidenced having discussed work outside class with one another, parents, etc.
    ___1.4 Asked question(s) which indicated curiosity
    ___1.5 Asked question(s) which indicated learning difficulty
    ___1.6 Took notes on lecture, solution of problems at blackboard, etc.
    ___1.7 Aggressively kept trying to understand, solve problems, etc.
    ___1.8 Became frustrated; gave up trying to understand, solve problems,etc.

2. Evidences of learning
    ___2.1 Reproduced previously presented ideas and/or solutions
    ___2.2 Used newly acquired vocabulary
    ___2.3 Recognized correct principle for solving a problem; applied principle correctly
    ___2.4 Solved new problems similar to previously explained ones
    ___2.5 Helped fellow pupils solve problem, learn principles, etc.
    ___2.6 Organized information, ideas, symbols into an optimal sequence
    ___2.7 Identified errors or defects in solution proposed by classmate(s)
    ___2.8 Identified errors or defects in solution by teacher, text, or other authority

3. Evidences of thinking
    ___3.1 Discovered relationship between two ideas, concepts, etc.
    ___3.2 Discovered complex relationship in pattern or system of symbols
    ___3.3 Visualized what a pattern or set of relationships would look like if rearranged
    ___3.4 Explored visually several solutions, courses of action, etc.
    ___3.5 Saw beyond the immediate and obvious
    ___3.6 Produced a diversity of possible solutions, applications of principles, etc.
    ___3.7 Abandoned conventional approach and thought of original solution
    ___3.8 Produced clever or uncommon responses
    ___3.9 Worked out the details to develop a general idea, solve a problem, etc
    ___3.10 Suggested a symbol (word, letter, number, etc.) that will satisfy a given relationship
    ___3.11 Used a principle, object, concept in a new way
    ___3.12 Suggested improved or new way of working, functioning as a class, etc

4. Other activities not included above (please list on back of this page)

If pupils experienced any particular difficulty in learning this material, please indicate the nature of the difficulty and what you did to cope with the problem. Also please add your evaluation and comments concerning the SMSG materials (Use back of this page.)

MINNESOTA NATIONAL LABORATORY - MATHEMATICS SECTION
SPECIAL ANALYSIS FOR FIRST MONTH

Name: ______________________________ Grade: ______________ Date: _________

Please pick out one of your most successful lessons this month and describe in detail what you think made this lesson so successful. You may include things which you did, things which pupils did, or any aspect of the total conditions for learning and thinking.

Topic of lesson: ____

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What do you consider the most important aims of this lesson? ___________

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What indications did you have that the lesson was successful? __________

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What actions, events, conditions, materials, etc. do you think contributed most to the success of this lesson? _______________________________

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MINNESOTA NATIONAL LABORATORY - MATHEMATICS SECTION
SPECIAL ANALYSIS FOR THIRD MONTH

Name:________________________________ Grade:__________ Date:__________

Please list the most persistent and recurrent learning difficulties your pupils have experienced this month. Then pick out the learning difficulty which bothers you most. In the spaces provided below list whatever hypotheses you have concerning the causes of this difficulty and what can be done to reduce this difficulty in this or other similar classes.

Most persistent and recurrent learning difficulties this month:__________

The learning difficulty which bothers you most:__________

Hypotheses concerning the causes of this difficulty:__________

Hypotheses concerning the reduction of this difficulty:__________

MINNESOTA NATIONAL LABORATORY - MATHEMATICS SECTION
SPECIAL ANALYSIS FOR FOURTH MONTH

Name:______________________________ Grade:________ Date:______

Please select some concept in mathematics which you have taught during the current term and then try to think of as many ways as you can for introducing this concept. After this, please answer the questions below as completely as you can.

What concept did you select?______________________________

How did you introduce this concept this term?______________________________

With what other methods for introducing this concept are you familiar? (Methods you have used, seen used, read about, or heard about?)________

What other methods for introducing this concept do you think might be successful?

MINNESOTA NATIONAL LABORATORY - MATHEMATICS SECTION
SPECIAL ANALYSIS FOR FIFTH MONTH

Name:______________________________Grade:__________Date:__________

What techniques or strategies have you used during the current month to motivate your pupils to learn and to think more effectively in this course? What other techniques or strategies might have been equally or more effective? You may include any scheme, device, requirement, assignment, reward, rule, or the like which you think might possibly be successful.

What techniques and strategies have you used during the current month?

What techniques and strategies might have been equally or more effective?

MINNESOTA NATIONAL LABORATORY - MATHEMATICS SECTION
SPECIAL ANALYSIS FOR SIXTH MONTH

Name:________________________________Grade:________Date:___________

As you have taught this and possibly other SMSG courses you have probably felt that existing tests and types of tests do not give your pupils a change to demonstrate their achievements on some of your most important objectives. Try to think of as many test ideas as you can for assessing some of the kinds of achievement in learning and thinking not now in use. In one section, list test ideas which involve modifications of traditional kinds of tests: tests of computational skills, problems, multiple-choice, true-false, completion, and the like. In a second section, list other test ideas.

Modifications of existing types of tests:

Ideas for types of tests not now in use:

MINNESOTA NATIONAL LABORATORY - MATHEMATICS SECTION
SPECIAL ANALYSIS FOR SEVENTH MONTH

Name:______________________________Grade:________Date:________

List below all of the problems which you can think of which might arise in initiating SMSG courses throughout your school at all grade levels.

MINNESOTA NATIONAL LABORATORY - MATHEMATICS SECTION
SPECIAL ANALYSIS FOR EIGHTH MONTH

Name:______________________________Grade:_________Date:__________

Many times during the current school term you have probably felt frustrated because your classroom was not suitable for some activity which would have stimulated learning and thinking among your pupils. Try to think of all of the characteristics a classroom would have to possess to make it ideal for teaching your SMSG course. Do not be concerned about cost or whether or not it is now possible to construct such a classroom. In the space below, write a description detailing your ideal classroom for this course. It would help if you would draw a sketch or sketches of this classroom. Attach drawings and additional descriptive material, if needed.

MINNESOTA NATIONAL LABORATORY - MATHEMATICS SECTION
SPECIAL ANALYSIS FOR NINTH MONTH

Name:______________________________Grade:____________Date:______________

What do you think would happen if SMSG courses in mathematics were to be adopted on a statewide basis in Minnesota three years hence? Consider both the immediate and long-range consequences. Consider any area in which you think such an event would have consequences.

MATHEMATICS CHECK-LIST

NAME OF TEACHER:______________________ Grade:____ SMSG____ or Other:___
(check one)

In your mathematics course this year, you have engaged in many activities. You have doubtless shown various evidences of interest, learning, and thinking. On the check-list below, please indicate the extent to which you believe that you have engaged in each of the activities listed below by checking the appropriate column. Consider the entire school term.

	Activities	Never	A few times	1 or 2 times a week	3 or 4 times a week	Almost every class	Every Class
1.	Studied assigned material						
2.	Read or studied unassigned material						
3.	Discussed work of course outside class with someone else						
4.	Asked questions out of curiosity						
5.	Asked questions because of learning difficulties						
6.	Took notes on lectures, solutions of problems, etc						
7.	Kept trying to understand new material, even though you didn't understand it at first						
8.	Became frustrated, gave up trying to solve problem						
9.	Solved problems which had previously been worked in class.						
10.	Used newly acquired terms and concepts						
11.	Applied principles correctly						
12.	Solved new problems similar to previously explained ones						
13.	Helped classmates solve problems, understand principles						
14.	Organized information and ideas into good form						
15.	Found errors or defects in solution by classmates						
16.	Found errors or defects in solution by teacher or text						
17.	Discovered relationships between two or more ideas, concepts or system of symbols						
18.	Worked out a diversity of possible solutions, applications of principles, etc						
19.	Gave up old approach and thought of a new approach to solving problems						
20.	Thought of an unusual but correct solution to a problem						
21.	Worked out the details of some project, series of problems						
22.	Used a principle or concept in a new way						
23.	Suggested improved or new ways of working as a class						

On the back of this sheet, describe the learning difficulty which has bothered you most in this class. Describe the nature of the difficulty and tell what you did to cope with it.

Report for Month of________________________

MINNESOTA NATIONAL LABORATORY - MATHEMATICS SECTION

Name of Teacher______________________________Grade________________

City________________________________School______________________

Number in Class__________________

INSTRUCTIONS: Promptly at the end of each month, please complete a set of these and return in the self-addressed, stamped envelope provided. If you misplace these envelopes, please send to the following address:

Bureau of Educational Research
330 Burton Hall
University of Minnesota
Minneapolis 14, Minnesota

DO NOT return these to the St. Paul office.

I. Please pick out one of your most successful lessons this month and describe in detail what you think made this lesson so successful. You may include things which you did, things which pupils did, or any aspect of the total conditions for learning and thinking.

Topic of lesson:____

What do you consider the most important aims of this lesson?__________

____

____

What indications did you have the lesson was successful?

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

What actions, events, conditions, materials, etc. do you think contributed most to the success of this lesson?

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

II. Please pick out one of your least successful lessons this month and describe in detail what you think made this lesson so unsuccessful. You may include your own activities, pupil activities, or any aspect of the total conditions for learning and thinking.

Topic of lesson:______________________________

What do you consider the most important aims of this lesson?______________

____

____

What indications did you have the lesson was unsuccessful?

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

4. ______________________________

____

5. ______________________________

____

What actions, events, conditions, materials, etc. do you think contributed to the lack of success of this lesson?

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

4. ______________________________

____

5. ______________________________

III. Please select some concept in mathematics which you have taught during the current month and then try to think of as many ways as you can for introducing this concept. After this, please answer the questions below as completely as you can.

What concept did you select?______________________________

____

How did you introduce this concept this term?____________________

____

____

With what other methods for introducing this concept are you familiar? (Methods you have used, seen used, read about, or heard about.)

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

What other methods for introducing this concept do you think might be successful?

1. ____

____

2. ____

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3. ____

____

4. ____

____

MINNESOTA STUDENT ATTITUDE INVENTORY

This is not a test because there are no wrong answers. The answer to each question is A MATTER OF OPINION, and your true opinion, whatever it is, IS THE RIGHT ANSWER. You will be asked a lot of questions about how much you like this class, the teacher, and the work you are doing here. All the questions refer to THIS ONE CLASS AND THIS PARTICULAR TEACHER. By giving frank, true answers to show exactly how you feel, you can help us understand the opinions of students.

DIRECTIONS:
1. Please do not write your name on the answer sheet.
2. Do not skip any questions--answer each one carefully.
3. Make sure that the number on the answer sheet matches the question number when you mark your answer. Double check when you are asked.

HERE IS AN EXAMPLE

0. I think my homework is very hard.
SD--STRONGLY DISAGREE D--DISAGREE U--UNCERTAIN A--AGREE SA--STRONGLY AGREE

You have five alternatives to choose from. You might STRONGLY DISAGREE with the statement. If so, you would put an "X" in the SD box on your answer sheet, like this:

0.	SD	D	U	A	SA
	X				
	e	m	l	b	j

If you felt UNCERTAIN about the statement, you would put an "X" in the U box on your answer sheet, like this:

0.	SD	D	U	A	SA
			X		
	a	b	l	d	j

Or, for example, you might AGREE with the statement, but not STRONGLY. If so, you would put an "X" in the A box, like this:

0.	SD	D	U	A	SA
				X	
	a	m	c	b	j

Pay no attention to the little letters under the boxes on your answer sheet.

And, DO NOT WRITE ON THIS QUESTIONNAIRE BECAUSE OTHER STUDENTS WILL HAVE TO USE IT.

1. This teacher asks our opinion in planning work to be done.
   SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

2. This teacher keeps order with a fair and firm hand.
   SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

3. I get along well with this teacher.
   SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

4. I find it easy to talk to this teacher.
   SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

5. This teacher never asks trick questions to show how dumb we are.
   SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

6. Most of us get pretty bored in this class.
   SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

7. This teacher never slaps us or handles us roughly.
   SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

8. No one dares talk back to this teacher.
   SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

9. This teacher is one of the best I have ever had.
   SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

10. I just don't trust this teacher.
    SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

11. It is easy to fool this teacher.
    SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

12. This teacher makes sure WE understand our work.
    SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

13. This teacher often sends boys and girls out of the room as punishment.
    SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

14. This teacher really understands boys and girls my age.
    SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

PAGE TWO

15. Our teacher is very good at explaining things clearly.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

16. Frankly, we don't pay attention to this teacher.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

17. This teacher has lost the respect of the class.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

18. Sometimes things "get out of control" in this class.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

19. This teacher certainly knows what he(she) is doing.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

20. This teacher often "bawls you out" in front of the class.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

21. This teacher makes it fun to study things.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

22. This teacher has some special favorites or "teacher's pets."
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

23. Our teacher never gives us extra assignments as punishment.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

24. This teacher wants to check our work to make sure we are on the right track.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

25. I really like this class.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

26. Sometimes I think this teacher is deaf.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

27. This teacher helps us get the most out of each hour.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

28. This teacher is cool and calm.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

29. In this class we fool around a lot in spite of the teacher.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

30. When I'm in trouble I can count on this teacher to help.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

31. This teacher becomes confused easily.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

32. This teacher will punish the whole class when he(she) can't find out who did something bad.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

33. This teacher thinks clearly.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

34. Some of the students are smarter than this teacher.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

35. This teacher lets us discuss things in class.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

36. It is fun to see how much we can whisper before we get caught.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

37. This teacher makes everything seem interesting and important.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

38. I wish I could get even with this teacher.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

39. This teacher knows a lot.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

40. This teacher is quick to see a new point.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

41. This teacher is too bossy.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

42. This teacher never gets angry and shouts at us.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

43. We often complain just to get out of work.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

44. If I could get away with it, I'd sure like to tell this teacher off!
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

45. This class is noisy and fools around a lot.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

46. This is the best teacher I have ever had.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

47. You can't walk around in this class without permission.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

48. It seems that somebody is always getting punished in this class.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

49. I wish I could have this teacher next year.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

50. This teacher has lots of fun with us.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

51. Sometimes just thinking about this class makes me sick.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

52. This teacher makes very careful plans for each day's work.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

53. This teacher helps students when they have problems with their work.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

54. Frankly, we just don't obey the teacher in this class.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

55. This teacher always takes time to find out your side of a difficulty.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

56. This teacher never pushes us or shakes us in anger.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

57. This teacher punishes me for things I don't do.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

58. This teacher likes to hear students' ideas.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

59. We behave well in this class even when the teacher is out of the room.
SD--STRONGLY DISAGREE D--DISAGREE U--UNDECIDED A--AGREE SA--STRONGLY AGREE

University of MINNESOTA

OFFICE OF EDUCATIONAL RESEARCH-MINNEAPOLIS 14

BUREAU OF INSTITUTIONAL RESEARCH
BUREAU OF EDUCATIONAL RESEARCH

March 21, 1962

Dear Teacher:

Enclosed you will find a student inventory that asks questions about the students' opinions regarding teachers, schools, classrooms and textbooks.

Please do not be intimidated by these "questions" for we are fully aware the student attitudes are not formulated by teachers, schools, classrooms and textbooks! As a matter of fact, the hypotheses we are testing in this study concern other factors not related to school as causes for student attitudes, hence the need for this "information."

However, if anyone is sufficiently naive to think that a student's attitude to his teacher is a direct correlate of the behavior of that teacher, then we would like to assure you that no such person would ever have access to these data. Apart from that everything will be handled by codes and machine immediately upon its arrival in this office. It is, therefore, unidentifiable and is, of course, even in this form, strictly confidential.

We would like this test to be filled out by each student in one SMSG class and also each student in one Control class. (Preferably at the same grade level.)

You will find in each envelope a set of instructions, 80 questionnaires (enough for two classes) and a self-addressed envelope for returning this confidential material to this office.

There is no time limit on the test for the students. We would like all testing to be completed before April 15.

Good luck and many thanks for all your past cooperation.

Sincerely,

E. Paul Torrance, Director
Bureau of Educational Research

EPT/gg

C 1

C 2 Teacher Code____

C 3

Grade:
C 4
7____7th grade
8____8th grade
9____9th grade
0___10th grade
1___11th grade
2___12th grade

C 5
0____SMSG
1____Control

Sex:
C 6
0____Boy
1____Girl

C 7 This teacher helps us to enjoy mathematics, even if we are not very good at math.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	k	l	d	e

C 8 My teacher has encouraged this class to think of original solutions to mathematical problems.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	b	c	m	n

C 9 In this class we do not pay attention.

SD	D	U	A	SA
( )	( )	( )	( )	( )
n	d	l	k	a

C 10 This teacher encourages us to make guesses at answers before we work them out.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	b	c	d	e

C 11 This teacher tries to find out anything which keeps us from understanding our work.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	b	c	d	e

C 12 My teacher has encouraged this class to discover relationships between two or more ideas, concepts, or systems of symbols.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	l	m	n

C 13 This teacher praises the class for good work done.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	k	c	m	e

C 14 This teacher enjoys discussing mathematics with us in class.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	l	m	n

C 15 This school has sensible rules which are easy for most of its students to obey.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	b	l	m	e

C 16 The textbook we use has problems which help us to try different but correct solutions to problems.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	c	d	n

C 17 In this class the students are not very interested in having everyone understand the material.

SD	D	U	A	SA
( )	( )	( )	( )	( )
e	d	l	k	j

C 18 My teacher has encouraged this class to think for itself at all times.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	k	l	d	n

C 19 In this class we have one of the most uncooperative classes I can think of.

SD	D	U	A	SA
( )	( )	( )	( )	( )
e	d	l	k	j

C 20 The textbook we use has helped us to get a good understanding of mathematics.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	l	d	e

C 21 In this class we like mathematics.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	b	c	d	e

C 22 This school has a good deal of resource materials for extra study and research.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	l	m	n

C 23 This school is not very well cared for and I consider it an unattrative place for the majority of its students.

SD	D	U	A	SA
( )	( )	( )	( )	( )
n	m	c	b	a

C 24 This textbook could not be blamed if we sometimes do not understand mathematics.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	l	d	e

C 25 My teacher has encouraged this class to think of unusual but correct solutions to various problems.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	b	c	m	n

C 26 This teacher encouraged us to think of reasons for our errors.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	k	c	d	n

C 27 This school has a staff which is interested in the students' welfare.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	b	l	m	e

C 28 This school would not be my choice if I could choose my school freely.

SD	D	U	A	SA
( )	( )	( )	( )	( )
e	m	c	b	j

C 29 The textbook we use contains problems which encourage us to think for ourselves.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	b	c	m	n

C 30 In this class we like to talk about math even when we are not in class.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	b	c	d	e

C 31 My teacher has encouraged this class to ask questions just out of curiosity.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	l	d	n

C 32 In this class we have one of the most conscientious and hard working classes in the school.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	b	l	m	e

C 33 My teacher has encouraged this class to make up problems of our own.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	l	d	n

C 34 In this class we come up with good ideas for solving problems.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	b	l	d	e

C 35 The textbook we use even helps us to "work ahead" of the teacher when we want to.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	k	c	d	e

C 36 This teacher makes the lessons interesting for this class.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	l	m	n

C 37 My teacher does not encourage this class to ask questions concerning our learning difficulties.

SD	D	U	A	SA
( )	( )	( )	( )	( )
e	m	c	k	a

C 38 This teacher wants us all to do as well as we can on our examinations.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	c	m	n

C 39 This teacher has encouraged this class to think of unusual uses for mathematics in real life.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	k	l	m	e

C 40 This teacher encourages us to attempt to solve problems even if we make mistakes.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	b	c	d	n

C 41 My teacher has encouraged this class to work out all kinds of possible solutions, applications, and principles in mathematics.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	b	c	d	e

C 42 In this class I like solving problems with my classmates.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	b	l	d	n

C 43 This teacher is very friendly towards this class.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	b	c	m	n

C 44 This teacher tries to make sure that we all understand our work.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	b	l	d	e

C 45 The textbook we use contains exercises which are not very interesting to work out.

SD	D	U	A	SA
( )	( )	( )	( )	( )
n	d	l	b	j

C 46 This school is helping the majority of its students become good citizens.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	l	d	e

C 47 This school is organized to help students in as many ways as possible.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	b	l	m	e

C 48 This school offers extra learning facilities which include a library, audio-visual aids, etc.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	k	l	d	e

C 49 My teacher has encouraged this class to discuss our work with other people outside of class.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	b	l	m	n

C 50 This school does not help students to develop their interests and abilities.

SD	D	U	A	SA
( )	( )	( )	( )	( )
n	m	l	b	a

C 51 My teacher has encouraged this class to find errors or defects in solutions proposed by teacher, textbook or classmates.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	b	l	m	n

C 52 The textbook we use could be much improved upon.

SD	D	U	A	SA
( )	( )	( )	( )	( )
e	m	c	k	a

C 53 The textbook we use helps us to understand points we did not quite understand during class.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	l	m	e

C 54 My teacher does not encourage this class to think of original mathematics problems for ourselves.

SD	D	U	A	SA
( )	( )	( )	( )	( )
n	d	l	k	a

C 55 My teacher has encouraged this class to read or study unassigned material.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	l	m	n

C 56 This school offers its students a wide range of interesting activities in which they can participate.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	l	m	e

C 57 In this class I get a sense of satisfaction at the end of a math period because we get things done.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	b	c	d	n

C 58 This teacher loves mathematics.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	k	l	d	e

C 59 My teacher has encouraged this class to give up old approaches and think of new ones to solve problems.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	b	c	m	n

C 60 This teacher tries to be fair to everyone in the class.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	k	l	m	n

C 61 This teacher helps us to profit from our mistakes.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	k	c	d	e

C 62 This school will do all it can to help any student in need of help.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	b	l	m	n

C 63 This textbook is hard to understand.

SD	D	U	A	SA
( )	( )	( )	( )	( )
n	m	c	b	a

C 64 In this class I am helped to understand new mathematical ideas because of everyone's efforts to work well.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	k	l	d	n

C 65 This textbook has diagrams and illustrations which help us to understand the material.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	b	c	d	e

C 66 My teacher has encouraged this class to work out and have our own answers to problems.

SD	D	U	A	SA
( )	( )	( )	( )	( )
j	k	l	m	n

C 67 This teacher encourages us to spot our own mistakes.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	b	l	d	n

C 68 This school does not make me feel proud to be one of its students.

SD	D	U	A	SA
( )	( )	( )	( )	( )
e	d	c	b	a

C 69 The textbook we use has not helped us to like mathematics.

SD	D	U	A	SA
( )	( )	( )	( )	( )
n	m	l	k	j

C 70 The textbook we use is full of interesting and important things to do.

SD	D	U	A	SA
( )	( )	( )	( )	( )
a	k	l	m	e